AUGUST 22, 2018
DRAFT DELTA SCIENCE PLAN UPDATE
PUBLIC REVIEW

This public draft, of the updated Delta Science Plan, was developed by the Delta Science Program and the Delta science and management community. Input or feedback received during the April 6, 2018 public workshop, the Delta Science Program internal review from May 22 to June 4, 2018, and Delta Stewardship Council Executive division review from June 18, 2018 to July 30, 2018 have been incorporated. Public comment is currently being sought for this draft.

Following the public comment period, the Delta Independent Science Board (DISB) will conduct a review. Input from both the public and DISB will be incorporated into a proposed final draft document and presented to the Delta Stewardship Council at the January 2019 Council meeting. A final document will be released between February and March 2019.

SUBMITTING PUBLIC COMMENT

The Delta Science Program encourages written public comments be submitted to science@deltacouncil.ca.gov. Please organize written comments by section title, heading, appendix, and page number, as well as provide the line number in the draft, figure number, and table number.

For public comment to be considered for incorporation in the draft Delta Science Plan for ISB review, comments must be received no later than Thursday, September 20, 2018.

THE FOLLOWING POINTS ARE RELEVANT TO THIS DRAFT OF THE UPDATED DELTA SCIENCE PLAN:

- List of Contents is not in final format.
- The Preamble is still under development and will not be included in this draft updated Delta Science Plan.
- Technical editing for all information in the draft updated Delta Science Plan, including grammatical details, will be ongoing.
- Layout, tables, and figures are preliminary or undergoing development. New figures will be inserted as they are completed.
- Glossary of terms may still undergo additions and changes.
- Citations and references are under development and will be inserted as they are completed.

MAJOR CHANGES TO THE DELTA SCIENCE PLAN

Below is an overview of major changes that have been made from the initial Delta Science Plan (2013) and the minor updates that were made in 2016. These changes include initial suggestions from the Delta Science Program, feedback received during early outreach to collaborative groups in the Delta, suggestions from the Delta Science Program's Science Advisory Committee, a public workshop held April 6, 2018, and the internal review by the Delta Science Program and Delta Stewardship Council Executive division.

This section does not include track changes.

Summary of major changes

Key changes were made in this current update of the Delta Science Plan to clarify, and more clearly include, the factors supporting a collaborative Delta science community. Key concepts that have been introduced and emphasized include the importance of social sciences and science governance. Nine new actions were added and eight of those actions were substantially changed to reflect the current state of science and improve organization. Four new appendices were added and these expand on the science governance discussion, provide the status of the science actions from the initial Delta Science Plan, introduce policy and procedures for scientific advisors, and discuss potential mechanisms for resources to support the Delta Science Plan implementation.

Objectives: changed order, adjusted wording

Objectives were re-ordered to align better with current chapters and a table (Table 1-3) has been added to indicate which actions contribute to meeting which objectives. In the original Delta Science Plan, there were "objectives" within each of the chapters with corresponding actions–to reduce confusion, those chapter objectives were removed.

New Objectives

1. Strengthen the science-management interface
2. Coordinate and integrate Delta science in a transparent manner
3. Enable and promote science synthesis
4. Manage scientific conflict
5. Support effective adaptive management
6. Maintain and advance understanding about the Delta

Introduction: included new concepts, progress, network map

Substantial revisions have been made to the introduction. These changes include: addition of a discussion on science governance with a network map of the Delta science-scape, a reflection on the progress since the initial release of the 2013 Science Plan in meeting the six objectives above, emphasizing the importance of social science, climate change and sea level rise as issues; updating the current management and policy context (e.g., updates to the Bay-Delta Water Quality Control Plan, WaterFix, Re-initiation of Consultation on the Biological Opinions, Water Infrastructure for Improvements to the Nation Act, etc.); and graphics of the current relationships among different entities in the Delta (Figure 1-2, Table 1-1).

Chapters: merged and reordered, refined introductory language, combined actions, removed actions, or added actions

There has been change in the order of chapters from the original Delta Science Plan. The reasoning for the current order is: strategies to increase policy and science interactions are important (chapter 2) but to do so a robust infrastructure to provide information is needed (chapter 3 instead of 4). This can then be used for adaptive management (chapter 4 instead of 3), which feeds back into policy-science interactions. Collective support is needed to successfully implement these actions (Chapter 5).

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NEW CHAPTER ORDER AND ACTIONS[1]

Chapter 1: Introduction*

Chapter 2: Establish shared mechanisms to effectively inform policy and management

- 2.1 Develop a framework for Policy-Science Forums**
- 2.2 Update and continue to implement the Science Action Agenda
- 2.3 Update and publish the State of Bay-Delta Science

Chapter 3: Modernize, integrate, and build the Delta science infrastructure

- 3.1 Host a summit to identify opportunities to utilize emerging technology*
- 3.2 Establish a social science task force and a strategy to nurture and integrate social science research in the Delta*
- 3.3 Develop a strategy that identifies current monitoring needs and facilitates monitoring program integration**
- 3.4 Establish a balanced portfolio of research funding programs and mechanisms in the Delta
- 3.5 Develop a shared framework that holistically addresses the data life cycle framework to support the goals of Assembly Bill 1755*
- 3.6 Continue and enhance support for existing web-based data systems including those currently outside the scope of AB 1755*
- 3.7 Promote accessibility to peer reviewed scientific literature, data, and tools
- 3.8 Develop a strategy to grow the collaborative modeling community**
- 3.9 Support high-priority model development**
- 3.10 Establish a shared set of best practices and protocols for focused synthesis**
- 3.11 Support opportunities that foster synthetic thinking throughout the Delta science and management communities**
- 3.12 Increase resources to conduct synthesis*
- 3.13 Continue consistent application of scientific peer review and independent science advisors
- 3.14 Develop, compile, and share methods for science communication to leverage existing efforts*
- 3.15 Support and enhance communication efforts and tools*

Chapter 4: Support effective decision-making through science-based adaptive management and decision-support tools

- 4.1 Implement adaptive management and structured decision-making approaches more consistently in natural resource management*
- 4.2 Provide Adaptive Management Liaisons
- 4.3 Hold regular Adaptive Management Forums

Chapter 5: Collectively support implementation of the Delta Science Plan

- 5.1 Facilitate development of coordinated Delta science implementation plans*
- 5.2 Develop a web-based tracking system of science activities in the Delta**
- 5.3 Establish shared mechanisms and processes for efficient funding
- 5.4 Maintain and grow the scientific expertise workforce needed to support Delta Science Plan implementation*
- 5.6 Develop and report performance measures**

APPENDICES: REORDERED TO MATCH CHAPTERS, REVISED CONTENTS, REMOVED SELECT ONES

Appendix A: Science governance and the collaborative Delta science-scape
New appendix

Appendix B: Status of original actions in 2013 Delta Science Plan and relevant topics
New appendix

Appendix C: Process for updating the Science Action Agenda

[1] * indicates new action, ** indicates substantially changed or moved

Revisions made including more detail on horizon scanning and top research questions

Appendix D: The State of Bay-Delta Science

Minor revisions made

Appendix E: Policies and procedures for independent science workshops

No substantial changes

Appendix F: Policy and procedures for independent scientific review

No substantial changes

Appendix G: Policy and procedures for independent scientific advisors

New appendix

Appendix H: Communication

Revisions made to be more applicable to the wider Delta science community

Appendix I: Delta Science Program Adaptive Management Liaisons

Minor revisions made

Appendix J: Potential shared mechanisms and processes for efficient funding to support Delta Science Plan implementation

New appendix

Appendix K: Policy and procedures for research funding

Minor edits, more may be coming

Appendix L: Conflict of interest policy for external research proposal and fellowship application reviewers, advisors, and applicant

Minor revisions made

<u>Removed Appendices</u>

Appendix: Performance measures

Added language to body of document

Appendix: Policy-Science Forum

Currently undergoing a pilot study; focus has changed substantially so will provide more details in next Delta Science Plan update

Appendix: Scientific Advisory Committee

Determined too Delta Science Program-centric

Appendix: Ecosystem restoration, DRERIP

Determined example is out of date

1 PREAMBLE (UNDER DEVELOPMENT)

ACKNOWLEDGEMENTS (UNDER CONSTRUCTION)

SUGGESTED CITATION

Delta Stewardship Council, Delta Science Program. 2018. Delta Science Plan

UTILIZATION OF THE DELTA SCIENCE PLAN

Achieving the vision of *One Delta, One Science* requires a sustained culture of cooperation and stewardship among policymakers, scientists, managers, and the interested public. The Delta Science Plan provides a framework for science cooperation across authorities vested in multiple agencies and programs. To build this lasting community of cooperation, the users and uses of this document include:

USERS	EXAMPLES OF HOW THE DELTA SCIENCE PLAN CAN BE USED
Science programs in the Delta[2]	♦ Guide where existing work groups or programs can collaborate ♦ Develop programs and work plans tiered from the broader actions identified in the Delta Science Plan and Science Action Agenda ♦ Increase interactions among agencies, stakeholders, and the public through meetings and forums; enhance coordination and ability to leverage existing resources ♦ Provide the context and shared approach for implementing priority science actions ♦ Integrate holistic thinking into project and program activities ♦ Support and utilize improvements to science infrastructure
Delta scientists	♦ Foster and enhance science networking and collaboration ♦ Integrate holistic thinking into project and program activities ♦ Enhance connections with Delta policy and management communities
Delta decision-makers[3]	♦ Provide input on and support for priority science needs ♦ Use high-quality science to inform decision-making ♦ Utilize scientific conflict management mechanisms ♦ Enhance connections with Delta scientists ♦ Support improvements to the science infrastructure (see Chapter 3)
Delta policymakers[4]	♦ Guide participation in Policy-Science Forum efforts and guide science that is useable for supporting decisions ♦ Guide coordination and integration among programs for implementing the Delta Science Plan ♦ Use high-quality science to inform decision-making ♦ Utilize scientific conflict management mechanisms ♦ Enhance connections with Delta scientists ♦ Support improvements to the science infrastructure (see Chapter 3)

[2] These include collaborative groups such as the Interagency Ecological Program and Delta Regional Monitoring Program but also individual programs within agencies and organizations focused on conducting science.

[3] These include both managers and agency directors and can also include stakeholders. Managers include individuals responsible for overseeing day-to-day functions (e.g. operations), implementing programs, research, policies, strategic planning, coordination and communication of the organization. Examples include participants of the Collaborative Adaptive Management Team, Interagency Ecological Program Science Management Team, and Delta Regional Monitoring Program Steering Committee. Directors are individuals who oversee agencies and large divisions (e.g. United State Geological Survey Bay-Delta region). Examples include members of the Collaborative Science and Adaptive Management Program, Delta Plan Interagency Implementation Committee and Interagency Ecological Program Director's Team participants.

[4] Individuals who develop policies for their agencies and departments and also those who participate at the legislative level who develop state-wide and nation-wide regulations.

USERS	EXAMPLES OF HOW THE DELTA SCIENCE PLAN CAN BE USED
Delta stakeholders[5]	♦ Provide input on priority Delta science activities ♦ Engage with Delta scientists and science community activities ♦ Integrate stakeholder perspectives into science-based decision-making ♦ Enhance connections among Delta policy, management, stakeholder, and science communities to promote co-production of science (see Chapter 2)
Interested public	♦ Provide input on priority Delta science activities ♦ Engage with Delta scientists and science community activities ♦ Enhance connections among Delta policy, management, and science communities
Delta Independent Science Board	♦ Provide oversight of scientific research, monitoring, and assessment of programs that support adaptive management of the Delta through periodic reviews of scientific research, monitoring, and assessment of programs at least once every four years (Water Code section 85280(3)) ♦ Inform recommendations for strategic science planning and activities ♦ Use high-quality science to inform its oversight and review activities

[5] Anyone or any entity who has an interest in, can influence, or will be affected by the issue, set of findings, or action (Haddaway et al., 2017).

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EXECUTIVE SUMMARY

The Delta Science Plan provides vision, principles, and approaches for collectively building a foundation of scientific knowledge in the Delta. This updated version of the Delta Science Plan expands on the initial 2013 Plan and seeks to identify opportunities to further the continued success of the original effort, as well as institute new initiatives to promote effective and sustainable science in regional management actions.

More specifically, the Delta Science Plan addresses how to use open and transparent processes to prioritize science activities, determine how these can be carried out most effectively and efficiently, and identify how the resulting information will be best communicated to those who need to use it (see "Users and uses of the Delta Science Plan" table on pg. iii). This Delta Science Plan is intended to be for the Delta science community and was developed in a collaborative process.

What does the Delta Science Plan achieve?

The plan sets a foundation for achieving the shared vision of *One Delta, One Science*. Or more specifically, an open Delta science community that works collaboratively to build a shared body of scientific knowledge with the capacity to adapt and inform water, environmental, and societal decisions. An open science community that is well-connected with the policy and management community and other users of science has the capacity to adapt and inform water and environmental decisions across multiple organizations and programs. It is an essential intention of the Delta Science Plan to augment and build on existing efforts and improve the existing science infrastructure. The shared body of knowledge includes both natural and social sciences and will be broadly accepted as credible, relevant, and legitimate. It will provide a solid scientific basis for making difficult management decisions about the Delta.

The vision of *One Delta, One Science* will be progressively achieved through collectively accomplishing the following six objectives:

1. Strengthen the science-management interface
2. Coordinate and integrate Delta science in a transparent manner
3. Enable and promote science synthesis
4. Manage scientific conflict
5. Support effective adaptive management
6. Maintain and advance understanding about the Delta

How will the vision of *One Delta, One Science* be achieved?

The Delta Science Plan proposes 26 actions to develop, coordinate, and communicate science and provide relevant, credible, and legitimate decision-support for policy and management actions. Implementing the Delta Science Plan will result in a vibrant community of scientists, working in an integrated manner, and producing science needed to reduce risks and increase resilience of the State's water supply, the Delta ecosystem, and the Delta as a place.

The Delta Science Plan is one element of a three-part planning, implementation, and reporting strategy. The other two components are the Science Action Agenda and the State of Bay-Delta Science. Together, these guiding documents are a joint venture to achieve the vision of *One Delta, One Science*.

During its 2013 review of the Delta Science Plan, the Delta Independent Science Board stated that this document has a rare opportunity to catalyze transformation of the prevailing "…legal, institutional, and cultural inertia in the system..." that tends to promote a paradigm of scientists and resource managers operating in agency and program silos. Such change was initiated in 2013 with the original Delta Science Plan, and it will continue through

collectively implementing the actions identified in the updated Delta Science Plan. For this to happen, the Delta science community will need to further embrace working together and develop innovative ways to leverage current and future resources.

CHAPTER 1. INTRODUCTION

Why do we need a Delta Science Plan?

The Sacramento-San Joaquin Delta (Delta) is a unique and complex system and a critical resource for California. The region faces many challenges that, if not managed effectively, will adversely affect millions of people and result in a dramatically altered ecosystem (Box 1-1). The importance of using science to inform management and policy decisions has been widely recognized in the Delta and was legally mandated with the passage of the Delta Reform Act in 2009. However, science alone cannot address the Delta's challenges (NRC, 2011); effective and collaborative science governance (see page x) is required to provide decision-makers[6] with credible, relevant, and legitimate (see Box 1-2) scientific information to guide management actions. Decision-makers must also recognize how these actions affect a wide range of interests in the Delta, such as agriculture, the economy, ecosystems, and cultural values.

Box 1-1. The Sacramento-San Joaquin Delta

Background

There are few other locations in the world where the outcomes of natural resource management decisions bear such significant consequences to the economy, ecosystem, and sense of place than the Sacramento-San Joaquin Delta (Delta). The region meets a large range of needs for California, including water supply for two-thirds of the State's population and critical habitat and migratory pathways for a diverse set of species—many of which are threatened or endangered. In addition, the Delta is home to over 570,000 residents and supports an agricultural and recreational economy tied to millions of people (Luoma et al., 2015; Lund et al., 2007). In spite of the large-scale reliance on the Delta, this highly complex and humanly altered system is at constant risk of catastrophic damage from sea-level rise, other climate change related outcomes, and stressors including floods, droughts, and earthquakes. In this rapidly changing and intricately connected system, resource management in the Delta has been termed a "devilishly wicked problem" (Luoma et al., 2015).

Geographic significance

The Delta is situated at the confluence of the Sacramento and San-Joaquin Rivers. The region is in the middle of the continuum of ecosystems and management issues connecting freshwater flows from the upper watershed to the larger estuarine system of the San Francisco Bay. Science and management issues for the Delta are directly linked to this broader context. However, given the complexity of the issues and the scope of the Delta Reform Act, the Delta Science Plan focuses primarily on the Delta and Suisun Marsh.

Today's Delta

New policies and regulatory initiatives have had wide reaching effects on several factors both in and outside the Delta. These policies and initiatives include the California WaterFix (2015), EcoRestore (2015), updates to the Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta (initiated in 2009), the Water Infrastructure Improvements for the Nation Act (passed in 2016), and California Assembly Bill 1755 (The Open and Transparent Water Data Act, passed in 2016). These regulations and actions have impacted water supply for local residents and those outside the Delta, the surrounding economy, agriculture, and the native, migratory, and introduced species that utilize the Delta. Management needs that will arise from these initiatives will rely on many of the actions identified the Delta Science Plan, including coordinated monitoring, updated modeling, synthesis, exploration of alternative futures, peer review, enhanced interagency efforts, and adaptive management.

[6] Throughout the rest of the document, we use "decision-makers" to include both directors and managers. These include both managers and directors and also stakeholders. Managers include individuals responsible for overseeing day-to-day functions (e.g. operations), implementing programs, research, policies, strategic planning, coordination and communication of the organization. Examples include participants of the Collaborative Adaptive Management Team, Interagency Ecological Program Coordinators Team, and Delta Regional Monitoring Program Steering Committee. Directors are individuals who oversee agencies and large divisions (e.g. United State Geological Survey Bay-Delta region). Examples include members of the Collaborative Science and Adaptive Management Program Policy Team, Delta Plan Interagency Implementation Committee and Interagency Ecological Program Director's Team participants.

Box 1-2: What is credible, relevant, and legitimate?

Credible: information was developed in a scientifically sound way and is from a trustworthy, authoritative, and recognized source

Relevant: information pertinent to the management need and delivered in a timely fashion

Legitimate: information that is policy-neutral, objective, developed and communicated using transparent and inclusive processes

The initial Delta Science Plan was developed in 2013 in response to a recommendation in the Delta Plan and the need to address regional science challenges. At that time, science activities in the Delta were primarily conducted by multiple entities in isolation, often with their own agenda and without an overarching plan for coordinating and organizing information among them (DSC, 2013). This fragmented approach led to incomplete scientific information, high uncertainty, different interpretations of data, and disagreements fueled by conflicting interests. Inefficient resource management actions leading to unsatisfactory outcomes were often taken to the courtroom, with proponents employing "combat science," or scientific knowledge generated for the purposes of advocating a political viewpoint, rather than to improve overall scientific understanding (Hanak et al. 2011).

The 2013 Delta Science Plan called for an update at least once every five years. These updates provide an opportunity to incorporate new concepts and actions relevant to the current science and management needs of the Delta. This document represents the first comprehensive review and update of the 2013 Delta Science Plan (Box 1-3).

Box 1-3. The 2018 Delta Science Plan review and update process

The 2018 review and update of the Delta Science Plan was conducted to incorporate additional concepts and actions reflecting the current science and management landscape in the Delta. For the content to be relevant to the regional needs of the Delta and to ensure broad acceptance of the Delta Science Plan as a useful and valuable framework, the update process involved early and continuous engagement from the wider Delta science community and public. Although the Delta Science Program has taken the role of leading the review and update effort, improvements to the Delta Science Plan rely on the regional science community to shape the content along with additional input and guidance from the Delta Independent Science Board, the Delta Science Program's Science Advisory Committee, and individuals with expertise in coordinating other complex systems.

Beginning in January 2018, the Delta Science Program engaged in early outreach efforts by approaching collaborative science groups such as the Collaborative Adaptive Management Team, the Delta Regional Monitoring Program, and the Interagency Ecological Program. At these meetings, the participants were requested to provide feedback on how they had used the Delta Science Plan in the past and to give initial suggestions on any concepts or topics that should be included in the updated document.

On April 6, 2018 the Delta Science Program hosted a workshop where the science community and public convened to discuss specific areas of the Delta Science Plan, provide recommendations for additional material, and to offer feedback on how the document could be improved. A total of 58 participants attended, representing 28 different entities. The workshop summary and materials that were provided at the event can be found here: http://deltacouncil.ca.gov/event-detail/15444

Highlights of additional concepts in this updated Delta Science Plan based on feedback from the early outreach and workshop include:

- Expanding the scope of the Science Action Agenda to include horizon scanning[a]
- Nurturing and integrating social sciences with the natural sciences and modernizing the science infrastructure
- Identifying strategies to promote data organization and accessibility focusing on steps prior to data publication
- Incorporating more detail and emphasis on coordinated monitoring
- Developing strategies for joint implementation of the Delta Science Plan

[a] Horizon scanning: a process to identify emerging trends, issues, and opportunities that mangers and scientists should be aware of so they are better prepared to take advantage of or to react to in a well thought out and timely manner (N.R Haddaway et al. 2017).

What is the Delta Science Plan, and what will it achieve?

The Delta Science Plan is a shared framework that serves as an overarching guide used by the Delta science community[7] as a tool for coordinating science activities[8], developing joint funding strategies, and reviewing and developing program-level strategic documents and annual work plans. It identifies strategies for improving the development, and communication of science to promote and assemble support for science activities that help support the coequal goals[9] and achieve the objectives of a coordinated, integrated, and open science community. This document, emerging from a collaborative process involving the broad Delta science community, is intended to be a guide for anyone actively participating in science and management efforts in the Delta.

The 2013 Delta Science Plan established the vision of *One Delta, One Science*, an open Delta science community that works collaboratively to build a shared body of scientific knowledge with the capacity to adapt and inform future water and environmental decisions (see Box 1-4). This update embraces this vision and identifies actions that will continue to move us towards *One Delta, One Science*. This document also emphasizes the need to increase collaboration among diverse entities and to improve *science governance* within the *Delta science enterprise*. Pages 9 - 10 and Appendix A discuss these concepts further and provide a series of network diagrams of the Delta science-scape, or the linkages among the various entities within the Delta science enterprise. These diagrams can be used to determine how different organizations and groups interact and provide insightson how to improve coordination and identify opportunities to stimulate efforts.

However, given its role as a shared framework, the Delta Science Plan does not explicitly identify specific research questions or monitoring programs that need to be enhanced, rather focused studies and programs should be further explored and developed within individual science programs and work plans of various agencies and collaborative groups (e.g., Interagency Ecological Program's science strategy, Delta Regional Monitoring Program's annual work plan), with coordination through the Delta Science Plan to ensure that these efforts are synergistic rather than duplicative. Examples of the users and uses of the Delta Science Plan are provided on page i.

Box 1-4. The Delta Science Plan Vision

The Delta Science Plan aims to achieve the vision of *One Delta, One Science Community* - an open Delta science community that works collaboratively to build a shared body of scientific knowledge with the capacity to adapt and inform future water and environmental decisions.

[7] The group of scientists, including federal, State, and local agencies; academics, consultants, non-governmental organizations, and interested public who are actively participating in scientific and management activities in the Delta.

[8] Science activities involve a broad range of efforts including compliance monitoring, modeling, exercises to identify science issues that may be of management concern in the near future, research focused on supporting decision-making, as well as more basic research that can support future management issues.

[9] The two goals of providing a more reliable water supply for California and protecting, restoring, and enhancing the Delta ecosystem. The coequal goals shall be achieved in a manner that protects and enhances the unique cultural, recreational, natural resource, and agricultural values of the Delta as an evolving place (California Water Code section 85054)

OBJECTIVES THAT WILL ACHIEVE THE VISION OF *ONE DELTA, ONE SCIENCE*

Success of the Delta Science Plan and collective progress towards the vision of *One Delta, One Science* will be met through achieving the following six objectives:

1. **Strengthen the science-management interface** – Promote more effective interactions between decision-makers, stakeholders[10], and scientists that lead to research supporting science-based management decisions and increased awareness of the human elements of decision-making.
2. **Coordinate and integrate Delta science in a transparent manner** – Implement shared approaches to organizing and integrating ongoing scientific activities to promote efficient use of emerging knowledge to inform decision-makers.
3. **Enable and promote science synthesis** – Improve existing collaborative mechanisms, high-level guidance, and increase staff capacity to conduct strategic syntheses of existing data to provide the best available science[11] in support of management and policy decisions.
4. **Manage scientific conflict** – Employ mechanisms to clarify the nature of conflicts, manage them, and deliver credible, relevant, and legitimate scientific information in a timely, independent, and transparent manner.
5. **Support effective adaptive management** – Plan and implement adaptive management consistent with the Delta Plan's adaptive management framework.
6. **Maintain and advance understanding about the Delta** – Support priority research and monitoring needs to advance knowledge of the Delta system and increase understanding of the Delta landscape on a watershed scale and as a component of the Bay-Delta estuary.

How will the vision of *One Delta, One Science* be achieved?

To achieve the vision of *One Delta, One Science* (Figure 1-1), the Delta Science Strategy encompasses three guiding documents: the Delta Science Plan, the State of Bay-Delta Science, and the Science Action Agenda. Each of these three documents play a different role (outlined below and see Table 1-1 for more details); together they provide the overall "strategy" to promote use and understanding of collaborative science in the Delta.

These documents alone cannot achieve the vision of *One Delta One Science*. Success will depend on the Delta science community's ability to embrace and implement the mechanisms and tools highlighted in this plan for performing science efforts to support natural resources management decisions.

The Delta Science Plan is the overarching document that identifies the tools, organizational structures, mechanisms, and actions needed for a more collaborative and integrated Delta Science community. Objectives and supporting actions lay the foundation for science in the Delta to be credible, relevant, and legitimate, produced collaboratively, conducted efficiently, and shared openly.

The State of Bay-Delta Science is a synthesis of the current scientific knowledge for the Delta that provides context for the Delta Science Plan. Specifically, the State of Bay-Delta Science communicates the state of knowledge to address key management needs, progress made on key research questions, and remaining knowledge gaps, which are used to guide updates to the Science Action Agenda.

The Science Action Agenda establishes prioritized science actions to achieve the objectives of the Delta Science Plan and to address key management issues. The science actions are specifically focused on filling gaps and

[10] A stakeholder is anyone or any entity who has an interest in, can influence, or will be affected by the issue, set of findings, or action (Liew 2007).

[11] Information and data generated through the application of a transparent and repeatable scientific process for informing management and policy decisions at a given point in time (MathWorks 2018). Best available science shall be consistent with the guidelines and criteria found in Appendix 1A of the Delta Plan (Wikipedia 2018).

promoting collaborative efforts. The Science Action Agenda serves as the common agenda from which agencies and programs can develop their own, more detailed science work plans (e.g., the Interagency Ecological Program Work Plan).

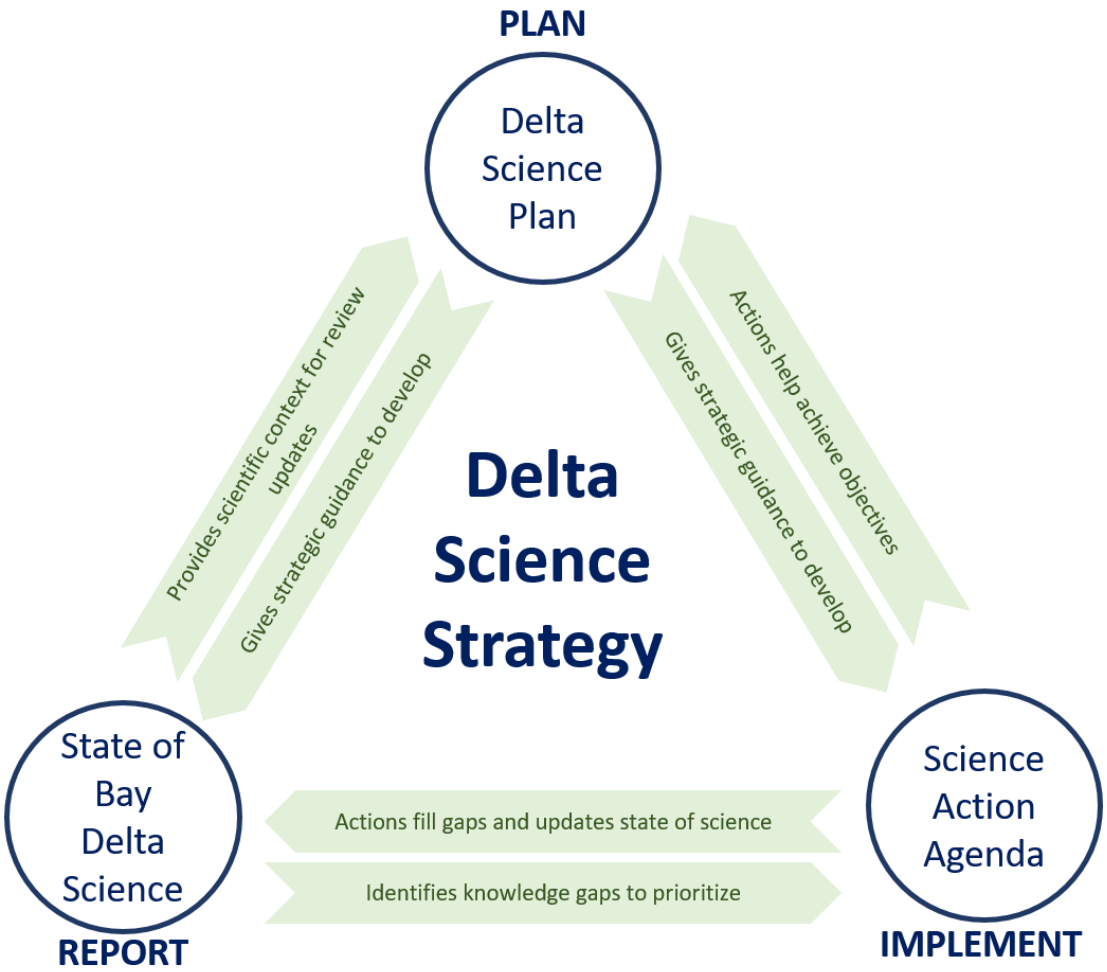
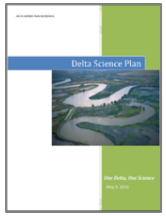


FIGURE 1-1. THE RELATIONSHIPS AMONG THE THREE ELEMENTS OF THE DELTA SCIENCE STRATEGY.

TABLE 1-1. SUMMARY COMPARISON OF THE DELTA SCIENCE STRATEGY DOCUMENTS: THE DELTA SCIENCE PLAN, THE STATE OF BAY-DELTA SCIENCE, AND THE SCIENCE ACTION AGENDA

Document	Purpose	What's inside	Time frame	Uses
The Delta Science Plan (will use updated cover) 	• The Delta science community's guide to "how we do science" to achieve the vision of *One Delta, One Science Community* • Identifies the tools, mechanisms, systems, and processes needed to optimize knowledge exchange among the different players in the Delta to gain a holistic understanding of the system	• A shared set of six objectives that collectively achieve the vision of *One Delta, One Science Community* • Actions that serve as the tools, mechanisms, systems, and processes to achieve the objectives	• First released in 2013 • Updated every five years to include new scientific concepts and mechanisms that achieve objectives • Objectives intended to be met over the long term (10+ years)	• Enhance connections between scientists, decision-makers, stakeholders and the public to marshal support for science infrastructure improvements and useable science • Include actions, mechanisms, and tools in agency and organizational work plans to promote better coordination and transparency
The *State of Bay Delta Science* 	• Synthesizes the current state of scientific knowledge on topics of high management concern in the Bay-Delta and where critical uncertainties remain • Highlights emerging trends of potential management concern in the future	• Topic-specific and peer-reviewed reports that summarize the scientific understanding of the Bay-Delta and implication for policy and management	• First released in 2008, second edition released in 2016 • Updated every four years, topics expected to change to reflect new insights from the previous edition	• Identifies knowledge gaps to guide updates to the Science Action Agenda • Provides decision-makers with an overview of the current state of knowledge to support management actions
The Science Action Agenda 	• Prioritizes science actions that achieve objectives in the Delta Science Plan and address priority management needs • Science actions are specifically those that require collaborative efforts, identify gaps, and support knowledge advancement • Identifies emerging trends and actions to prepare future management response • Builds on topics identified in the Interim Science Action Agenda	• A prioritized set of science actions and management needs • (Future updates) Emerging ecological and sociological trends with management implications and associated science actions to support decision-making	• First released in 2017 • Updated every four years, identifies near-term science actions and highlights any science needs on the horizon	• Identifies science topics for proposal solicitation packages and collaborative science initiatives • Guides contents of science work plans • Supports justification for budget change proposals • Identifies actions that provide knowledge for updates to *SBDS*

Visualizing the collaborative network structure of the Delta science enterprise to inform science governance

Collaborative science governance and the science enterprise

Collaborative science governance includes the processes and structures that determine how the science community prioritizes science questions, collectively funds high-priority science activities, carries out these activities, and communicates the resulting information to decision-makers and other users.[12,13] These structures and processes are intended to engage members of the science community across agency boundaries, universities, organizations, stakeholders, and the public.

Principles of good science governance include (European Commission, 2009, DSC, 2016):

1. Openness and transparency
2. Public participation
3. Accountability clearly apportioned among institutions
4. Effectiveness in achieving goals and objectives
5. Coherence among institutions and policies

Collaborative science governance encompasses both the *science enterprise*[14] and the interactions among all of the different players within the enterprise. The importance of the science enterprise and its governance was highlighted in the recommendations from the 2016 Science Enterprise Workshop, which focused on improving science funding, management, and communication in the Delta.

The need to visualize the Delta science enterprise

Prioritizing and funding science efforts across a complex science regime like that in the Delta requires a holistic understanding of the relationships among the different elements of the science enterprise. A landscape-scale awareness allows for important insights regarding better coordination and funding of science activities that address complex regional resource issues and to make science useable for management decisions. Social network analysis is a useful tool for understanding such complex system. Figure 1-2 is a network map generated in response to a need for a better understanding of collaborative interactions among organizations in the Delta. The network map showcases the Delta "science-scape", or the system of social organizations that participate in the Delta science enterprise and contribute to collaborative science governance in the Delta. This network diagram is a starting point and focuses on the structure of the relationships. Future analysis will address the nature of these relationships and the processes contributing to decisions across collaborative organizations (e.g. the flow of funding and information). The goal for the series of network maps and analyses is to serve as a tool to improve collaborative science governance in the Delta. For additional discussion on collaborative science governance and the network of organizations and collaborative science venues, see Appendix A.

[12] This definition was derived using language set forth by multiple authors including Lebel et al. (2005) and Raik & Decker (2007).
[13] One common component of science governance is the "regulation" of science but this is not an aspect of the science governance in the Delta. Instead, the focus is on the coordination, facilitation and communication aspects of science governance.
[14] The collection of science programs and activities that exist to serve managers and stakeholders in a regional system

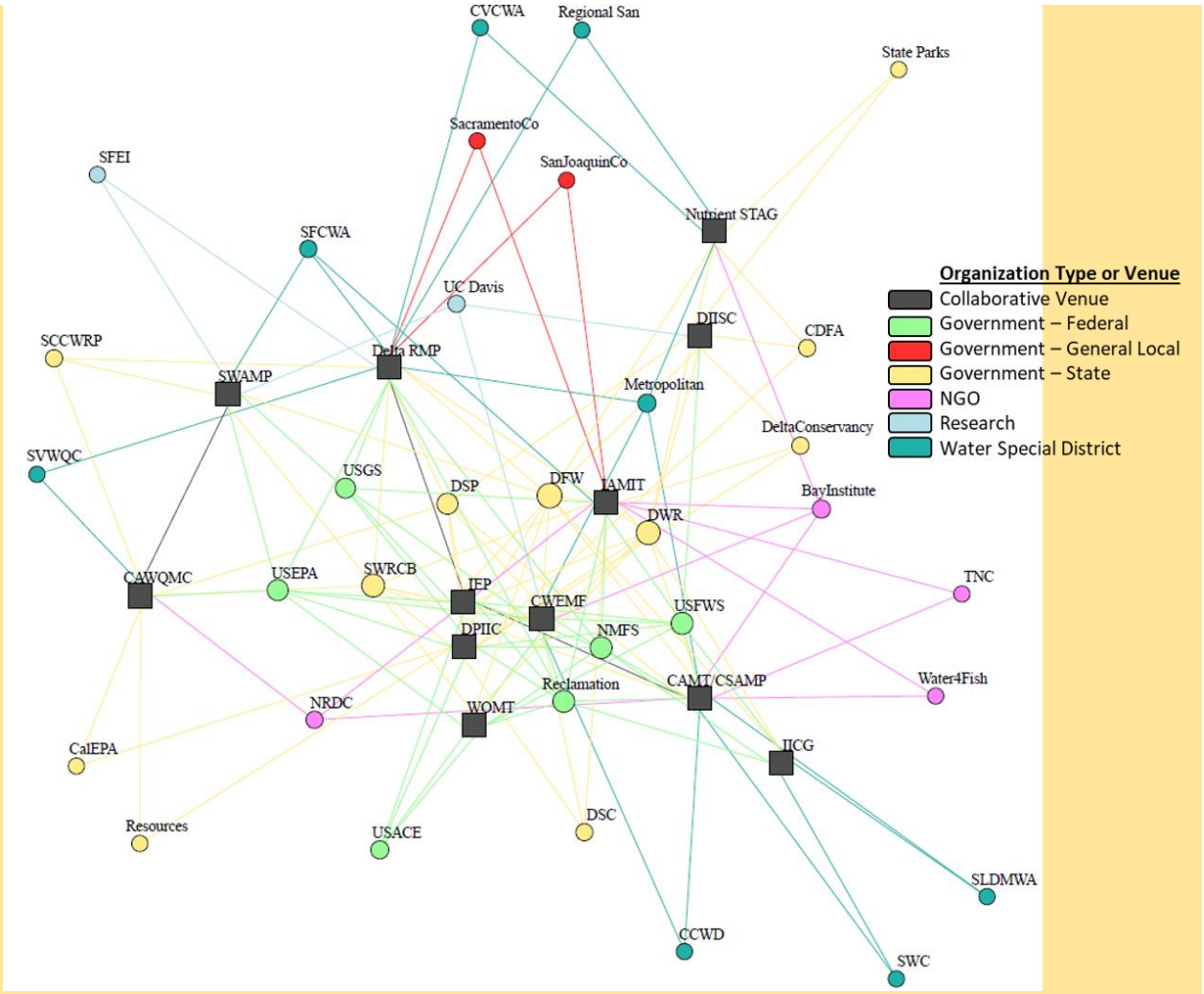


FIGURE 1-2. THIS NETWORK DIAGRAM SHOWS THE 12 MAIN COLLABORATIVE DELTA SCIENCE VENUES (BLACK) AND ALL OF THE ORGANIZATIONS (COLORS) THAT PARTICIPATE IN MORE THAN ONE SUCH VENUE (THE "CORE" NETWORK). ORGANIZATIONS ARE CONNECTED WITH TIES (GREY LINES) TO VENUES THEY PARTICIPATE IN. THE MORE TIES AN ORGANIZATION OR VENUE HAS, THE MORE CENTRALLY LOCATED THEY ARE IN THE DIAGRAM. APPENDIX A DISCUSSES THIS NETWORK AND THE COLLABORATIVE DELTA SCIENCE "FULL" NETWORK AND PROVIDES FURTHER EXAMINATION OF VENUES AND PARTICIPATING ORGANIZATIONS AND HOW THEY CONTRIBUTE TO COLLABORATIVE SCIENCE GOVERNANCE. FOR LIST OF ACRONYMS, SEE APPENDIX A.

What has been achieved so far?

Since the initial release of the Delta Science Plan in 2013, much progress have been made towards meeting the six objectives that achieve the vision of *One Delta, One Science*. There have been substantial advances in the scientific understanding of the Delta system, increased science coordination, and improved communication to support decision-making. Highlights of efforts supporting the six objectives are provided below. An overview of the status of each of the actions from the 2013 Delta Science Plan can be found in Appendix B.

Objective 1: Strengthening the policy-science interface

Several venues have emerged that provide for more effective communication between decision-makers, scientists, and stakeholders. These include the Collaborative Science and Adaptive Management Program and associated Collaborative Adaptive Management Team, Nutrient Stakeholder and Technical Advisory Group, and Delta Regional Monitoring Program. Science panels at the Delta Plan Interagency Implementation Committee meetings have engaged with regional directors and agency leaders to provide an overview of the state of knowledge. Venues such as the biennial Bay-Delta Science and State of the Estuary conferences, 2016 Science Enterprise Workshop provide opportunities for managers and scientists to interactively discuss the current state of science and remaining management needs. The release of the 2016 State of Bay Delta Science and 2017-2021 Science Action Agenda offered additional pathways to distill the scientific knowledge base and to identify critical science actions to support near-term management issues.

Objective 2: Coordinating and integrating Delta science in a transparent manner

The 2013 Delta Science Plan action 4.3.1 called for a summit to explore data sharing and infrastructure needs in the Delta. A data summit was held in 2014 and the ensuing white paper, *Enhancing the Vision for Managing California's Environmental Information J Durand et al., "Drought and the Sacramento-San Joaquin Delta, 2012-2016: Synthesis Review and Lessons," Submitted, 2018.*, played an integral part in informing Assembly Bill 1755, the Open and Transparent Water Data Act. Improvements to web-based information tools and data platforms (e.g., California Water Quality Monitoring Council's My Water Quality portals, Bay Delta Live, EcoAtlas) have improved access to data, while groups such as the Interagency Ecological Program and Bay and Delta Regional Monitoring Program are working to increase coordination among monitoring groups.

Objectives 3: Enabling and promoting science synthesis

The Interagency Ecological Program's Management, Analysis, and Synthesis Team has produced several synthesis documents including the fall low-salinity zone (Brown et al. 2014) and an updated conceptual model for Delta Smelt, which played a key role in the development of the Delta Smelt Resiliency Strategy (CNRA, 2016). The 2015 High Impact Science Actions (DSP, 2015) spurred the development of a drought synthesis (Durand et al. 2018) and the 2016 the State of Bay-Delta Science provided concise overviews of management-relevant science topics. Several synthesis workshops have taken place, some with ensuing synthesis documents, covering topics including invasive aquatic species, Delta Smelt and Longfin Smelt, contaminants of emerging concern, and effects of pathogens and disease on salmon (Coastal and Marine Sciences Institute (CMSI) 2016, n.d.; Surface Water Ambient Monitoring Program (SWAMP) 2017; Ta et al. 2017).

Objective 4: Managing scientific conflict

Independent scientific review has played a key role in building trust and credibility regarding the use of science in reports and programs. The Delta Science Program has facilitated multiple reviews of contentious topics using the policies and procedures outlined in Appendix F regarding scientific review. Past reviews include the Biological Opinion for the California WaterFix, the Long-term Operations Biological Opinions for the Central Valley Project and State Water Project, and the analytical tools for assessing Yolo Bypass salmon habitat restoration and fish passage project. The Collaborative Science and Adaptive Management Program/Collaborative Adaptive Management Team and Delta Regional Monitoring Program provide opportunities for members of both the

regulated and regulating communities to come together and collaboratively identify and discuss research and monitoring needs to build a common understanding of the system and inform resource management.

Objective 5: Supporting effective adaptive management

The concept of adaptive management has become increasingly mainstream in restoration and water management discussions in the Delta. In response to an action in the 2013 Delta Science Plan, the Delta Science Program established the Adaptive Management Liaisons to facilitate incorporation of adaptive management into restoration plans in the Delta. In 2016, the Delta Independent Science Board released a review of adaptive management in the Delta. The review also included recommendations to improve the application of adaptive management such as increasing flexibility in funding and management decisions for more nimble responses. Building off these recommendations, the Interagency Adaptive Management Implementation Team has led development of a white paper to provide guidance for implementing an adaptive management program to support future restoration efforts in the Delta and Suisun Marsh. Other efforts using adaptive management principles include the Nutrient Stakeholder Technical Advisory Group and the Collaborative Science and Adaptive Management Program efforts associated with the Delta Smelt and Salmonid Resiliency Strategies(CNRA, 2016; 2017).

Objective 6: Maintaining and advancing understanding about the Delta

In the past five years, several science efforts have contributed information needed to fill critical knowledge gaps. These include synthesis, monitoring, and research activities supported by the Interagency Ecological Program and research funded by both the Delta Science Fellowship program and California Department of Fish and Wildlife's Proposition 1 grant program.[15] Knowledge gained from these efforts have been communicated through the publication of Delta-focused scientific reports and articles, while synthesis of this information support a more comprehensive understanding of the Delta. Numeric and conceptual models such as the salmon life-cycle model (NMFS, 2017) called for in the 2015 High-Impact Science Actions (DSP, 2015) and the mercury cycling model have been instrumental in shedding light on how multiple ecosystem components (e.g., fish movement, contaminant transport, food web mechanisms) interact with each other and how management actions can affect these relationships.

What are some remaining challenges?

The Delta science community has taken considerable steps in building trust and working together in addressing the Delta's many challenges. Below are some areas that, when addressed, will bring the Delta science enterprise closer to more fully achieving the objectives of the Delta Science Plan.

More effective knowledge transfer among scientists, stakeholders, and decision-makers

The knowledge transfer between scientists and decision-makers is inefficient resulting in reactive and uncoordinated management. Ecological change can take decades but there is a widespread tendency to focus on urgent matters, leading to a lack of consideration for challenges on the horizon and beyond (Delta ISB, 2017a; Luoma et al. 2015; Healey, et al., 2016). Research that investigate complex ecological processes often uncover new insights that result in additional questions but there is not enough support for further exploration. Decision-makers need to understand that updated scientific knowledge is essential to properly answer management questions but those developing the scientific information must also be able to communicate the relevance of their findings to the need at hand. Deliberate and frequent interactions among scientists, stakeholders, and managers are needed to exchange information and will help to build trust within the Delta.

[15] Watershed and Restoration Delta Water Quality and Ecosystem Restoration grant program

Transparency and Coordination

There are still disagreements associated with the use and interpretation of scientific data (Durand et al. 2018). These realities underscore the need for greater transparency and coordination among agencies in the Delta. Prioritizing data sharing and organization, peer review, and strategies to synthesize information quickly are also needed to both collaboratively manage and understand the system as well as to identify science needed to resolve disagreements and ambiguity in policymaking discussions.

Importance of the Social Sciences

There is still limited understanding of the human values of the Delta as a place and the social and economic processes that underlie these values (Delta ISB, 2017). Modeling efforts should integrate socio-economic parameters and research should emphasize the social sciences to support understanding how land and water use, species interactions, and chemical pathways interact.

Comprehensive Adaptive Management

Better coordination and integration of adaptive management in various management activities in the Delta is needed, as the concept is not completely understood nor completely executed (Wiens et al. 2017). There is a need for system-wide support of adaptive management and strategies to better clarify how different stages of adaptive management should be implemented. Meeting these needs will require additional funding for facilities and staff to carry out these efforts.

Organization of the Delta Science Plan

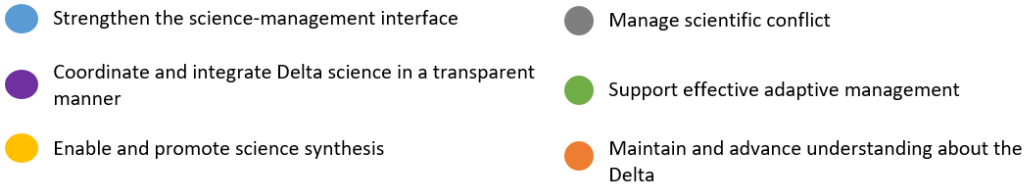
The remaining chapters in the Plan describe the critical science needs in the Delta and identify actions that will achieve its objectives. These actions include new initiatives and existing efforts that need continued support and are organized in four thematic chapters. Within each chapter, background information and boxes highlight "Efforts to Build On." These existing efforts are included as examples and are not intended to be comprehensive. For each action or suite of actions, the primary responsibility (i.e., facilitating or leading) and action participants (i.e., joint development or implementation responsibilities) are identified. Table 1-2 provides a summary of actions identified in this document and the objectives they address.

Delta Science Plan Chapters

- Chapter 1. Introduction
- Chapter 2. Establish shared mechanisms to effectively inform policy and management
- Chapter 3. Modernize, integrate, and build Delta science infrastructure
- Chapter 4. Support effective decision-making through science-based adaptive management and decision support tools
- Chapter 5. Collectively support implementation of the Delta Science Plan

TABLE 1-2. SUMMARY OF ACTIONS AND THE CORRESPONDING OBJECTIVES THEY ADDRESS.

Action	Title	Objectives addressed
2.1	Develop a framework for Policy-Science Forums	
2.2	Update and continue to implement the Science Action Agenda	
2.3	Update and publish the State of Bay-Delta Science	
3.1	Host a summit to identify opportunities to utilize emerging technology	
3.2	Establish a social science task force and a strategy to nurture and integrate social science research in the Delta	
3.3	Develop a strategy that identifies current monitoring needs and facilitates monitoring program integration	
3.4	Establish a balanced portfolio of research funding programs and mechanisms in the Delta	
3.5	Develop a shared framework that holistically addresses the data life cycle to support the goals of Assembly Bill 1755	
3.6	Continue and enhance support for existing web-based data systems including those currently outside the scope of AB 1755	
3.7	Promote accessibility to peer reviewed scientific literature, data, and tools	
3.8	Develop a strategy to grow the collaborative modeling community	
3.9	Support high-priority model development	
3.10	Establish a shared set of best practices and protocols for focused synthesis	
3.11	Support opportunities that foster synthetic thinking throughout the Delta science and management communities	
3.12	Increase resources to conduct synthesis	
3.13	Continue consistent application of scientific peer review and independent science advisors	
3.14	Develop, compile, and share methods for science communication to leverage existing efforts	
3.15	Support and enhance communication efforts and tools	
4.1	Implement adaptive management and structured decision-making approaches more consistently in natural resource management	
4.2	Provide Adaptive Management Liaisons	
4.3	Hold regular Adaptive Management Forums	
5.1	Establish shared mechanisms and processes for efficient funding	
5.2	Facilitate development of coordinated Delta science implementation plans	
5.3	Develop a web-based tracking system of science activities in the Delta	
5.4	Maintain and grow the scientific expertise workforce needed to support Delta Science Plan implementation	
5.5	Develop and report performance measures	



Moving forward

Collective action is needed by the Delta science community to develop innovative ways to implement the actions and achieve the objectives called for in the Delta Science Plan. Given current resource limitations, seven high-priority science actions were identified, based on input from the April 6, 2018 public workshop[16]; these should be initiated within the first year of implementing this updated Delta Science Plan (Table 1-3).

TABLE 1-3. HIGH-PRIORITY ACTIONS TO ADDRESS WITHIN THE FIRST YEAR OF THE UPDATED DELTA SCIENCE PLAN IMPLEMENTATION.

Action	Title
2.1	Develop a framework for Policy-Science Forums
3.3	Develop a strategy that identifies current monitoring needs and facilitates monitoring program integration
3.8	Develop a strategy to grow the collaborative modeling community
3.12	Increase resources to conduct synthesis
3.14	Develop, compile, and share methods for science communication to leverage existing efforts
5.1	Establish shared mechanisms and processes for efficient funding
5.2	Facilitate development of coordinated Delta science implementation plans

[16] Please see the workshop summary for more information http://deltacouncil.ca.gov/docs/delta-science-plan/2018-delta-science-plan-review-and-update-public-workshop-summary-april-6

CHAPTER 2. ESTABLISH SHARED MECHANISMS TO EFFECTIVELY INFORM POLICY AND MANAGEMENT

Transforming how policy, management, and science communities interact and exchange information is essential for identifying and addressing complex questions and issues surrounding natural resources management in the Delta. Effective policy-science interactions require early engagement, continuous dialogue, learning each other's "language," and embracing opportunities to establish innovative approaches for developing and using best available science. This chapter identifies new mechanisms and tools to support regular and effective interactions among decision-makers, scientists, and stakeholders to provide a holistic understanding of the shared needs within the Delta system. Actions in this chapter are intended to collectively identify connections among ongoing efforts, highlight where both coordination and collaboration can occur to fill gaps, and strengthen a shared understanding of the Delta.

Develop guidelines to improve policy-science interactions

PROBLEM STATEMENT

Currently there are no regionally established and agreed upon processes to guide interactions among decision-makers, scientists, and stakeholders to effectively link scientific knowledge and management needs for the Delta. This lack of communication can lead scientists to design projects without understanding the management and regulatory context, resulting in research that may not be directly relevant to management needs. Similarly, managers can struggle to convert their decision-making uncertainties into questions that frame feasible scientific studies and determine the most appropriate application of existing scientific information. Meanwhile, stakeholders raise concerns about their level of inclusion in identifying management needs and the options for addressing them.

Efforts to Build On:

- Collaborative Science and Adaptive Management Program
- Collaborative Adaptive Management Team
- Delta Plan Interagency Implementation Committee
- The 2016 Science Enterprise Workshop
- Science panels at conferences and workshops
- Delta Regional Monitoring Program
- Salmonid workshop hosted by CAMT and the National Oceanic and Atmospheric Administration

There is a need for mechanisms that result in co-produced science. Science co-production occurs when managers, decision-makers, scientists, and stakeholders work collaboratively to identify management issues and decisions that need to be informed using science and to brainstorm research questions and strategies for the appropriate use of science (Beier et al. 2017). Establishing shared mechanisms that support co-produced Delta science strengthens the relationships among decision-makers, scientists, and key stakeholders, while increasing the transparency, legitimacy, relevancy, and acceptance of the product or outcome by the wider community. In the Delta, existing organizational structures such as the Collaborative Science and Adaptive Management Program support co-produced science using forums involving decision makers, scientists, and stakeholders.

ACTION TO SUPPORT THE NEED

2.1 Develop a framework for Policy-Science Forums

Develop a framework that includes guidelines for establishing Policy-Science Forums across a range of scientific issues and best practices to facilitate science co-production and learning among decision-makers, scientists, and stakeholders. Objectives of Policy-Science Forums include identifying priority scientific uncertainties and improving scientists' understanding of policy issues and priority management questions. This framework should build on lessons learned from past discussions on Policy-Science Forums (e.g.

suggestions from the Delta Science Program's Science Advisory Committee) and on the outcomes of the pilot Policy-Science Forum associated with the Collaborative Adaptive Management Team Delta Smelt Scoping Team.

Primary responsibility: Delta Science Program, Collaborative Science and Adaptive Management Program/Collaborative and Adaptive Management Team, Interagency Ecological Program (IEP) and IEP Lead Scientist

Action participants: Delta Plan Interagency Implementation Committee, Delta Agency Science Workgroup, local and regional stakeholders, lead scientists, and agency directors and coordinators with an interest in facilitating knowledge exchange among scientists and decision-makers

EXPECTED OUTCOMES

- Continued and expanded interactions at the policy-science-management interfaces
- Shared understanding of best available science and critical uncertainties among scientists, decision-makers, and stakeholders
- Improved linkages between priority management issues and completed scientific research
- Increased opportunities for science co-production

Prioritize science activities that address key management needs

PROBLEM STATEMENT

In the Delta, numerous management issues are acknowledged by multiple entities yet, many issues are not addressed because the needs either fall between the mission and goals of any one entity or cannot be tracked by any individual group. The Science Action Agenda was developed to provide a common agenda that prioritizes collectively-identified management needs and science actions, as well as a unifying framework for addressing these gaps (additional information in chapter 1 and Appendix C). In this way, the Science Action Agenda serves as a tool to prioritize science actions that fill critical gaps in Delta science and brings the Delta science community together to jointly tackle these issues. Future updates to the Science Action Agenda will be integral to be responsive to current and future management and policy needs.

ACTION TO SUPPORT THE NEED

2.2 Update and continue to implement the Science Action Agenda

Update the Science Action Agenda in 2021 using inclusive processes that integrate science activities across agencies and programs to address key management challenges as described in Appendix C. This update effort will include results from horizon scanning[17] exercises to ensure that newly emerging scientific issues are incorporated into future efforts. Following the development of topic-specific Delta science implementation plans described in Chapter 5, the Science Action Agenda may also be formatted to serve as a starting point for detailed science work plans.

Primary responsibility: Delta Science Program, Delta Agency Science Workgroup

Action participants: Wider Delta science community

[17] Horizon scanning: a process to identify emerging trends, issues, and opportunities that mangers and scientists should be aware of so they are better prepared to take advantage of or to react to in a well thought out and timely manner (N.R Haddaway et al. 2017).

EXPECTED OUTCOMES

- Ongoing and collaborative prioritization of science actions
- Integrated science efforts and work plans among agencies and programs
- More clearly articulated impetus for joint funding strategies and opportunities

Update and communicate the state of science for the Delta system

PROBLEM STATEMENT

Clear communication of the state of scientific understanding for topics of high management concern is essential to ensure the best available science is used in decisions and that future research endeavors target the remaining uncertainties or knowledge gaps. Failure to communicate the Delta's state of scientific knowledge leads to using outdated information in important decisions and scientific research disconnected from management priorities. The State of Bay-Delta Science is a publication intended to inform science and policy audiences about current scientific understanding of the Bay-Delta system. The collection of papers that form the State of Bay-Delta Science provide updates on key scientific advances and findings, draw clear linkages between science and management needs, highlight important innovations that have developed and supported the advancement of knowledge, and identify remaining questions.

ACTION TO MEET THE NEED

2.3 Regularly update and publish the State of Bay-Delta Science

Publish the next edition of the State of Bay-Delta Science in the next three years to update and communicate the state of science and knowledge about the Bay-Delta system. The next edition will include a strong focus on communicating effectively to both policy and science audiences. Additional details on the process for updating the State of Bay-Delta Science can be found in Appendix D.

Primary responsibility: Delta Science Program, Delta Lead Scientist

Action participants: Delta Plan Interagency Implementation Committee, relevant experts

EXPECTED OUTCOMES

- Ongoing assessments of the state of scientific knowledge that reflects the dynamic nature of the Bay-Delta system, advances in technologies, and the rapidly growing knowledge base
- Improved communication among scientists, stakeholders, and decision-makers to ensure the state of the science is synthesized in a timely manner to inform management need

CHAPTER 3. MODERNIZE, INTEGRATE, AND BUILD THE DELTA SCIENCE INFRASTRUCTURE

Science that informs policy and management decisions is built on a foundation of monitoring, research, data management, models, synthesis, peer review, and communication (Figure 3-1). This chapter describes these fundamental elements or "science infrastructure" that are necessary to understand how the Delta functions from regional to watershed scales and to manage them efficiently. Science infrastructure is defined here as the equipment, tools, resources, systems, and processes that support the production, organization, and communication of scientific knowledge. These elements alone do not result in a well-functioning science enterprise; they must be organized and linked so that information is efficiently transferred from those generating data to decisions-makers and the broader public (see Chapter 2 for supporting mechanisms).

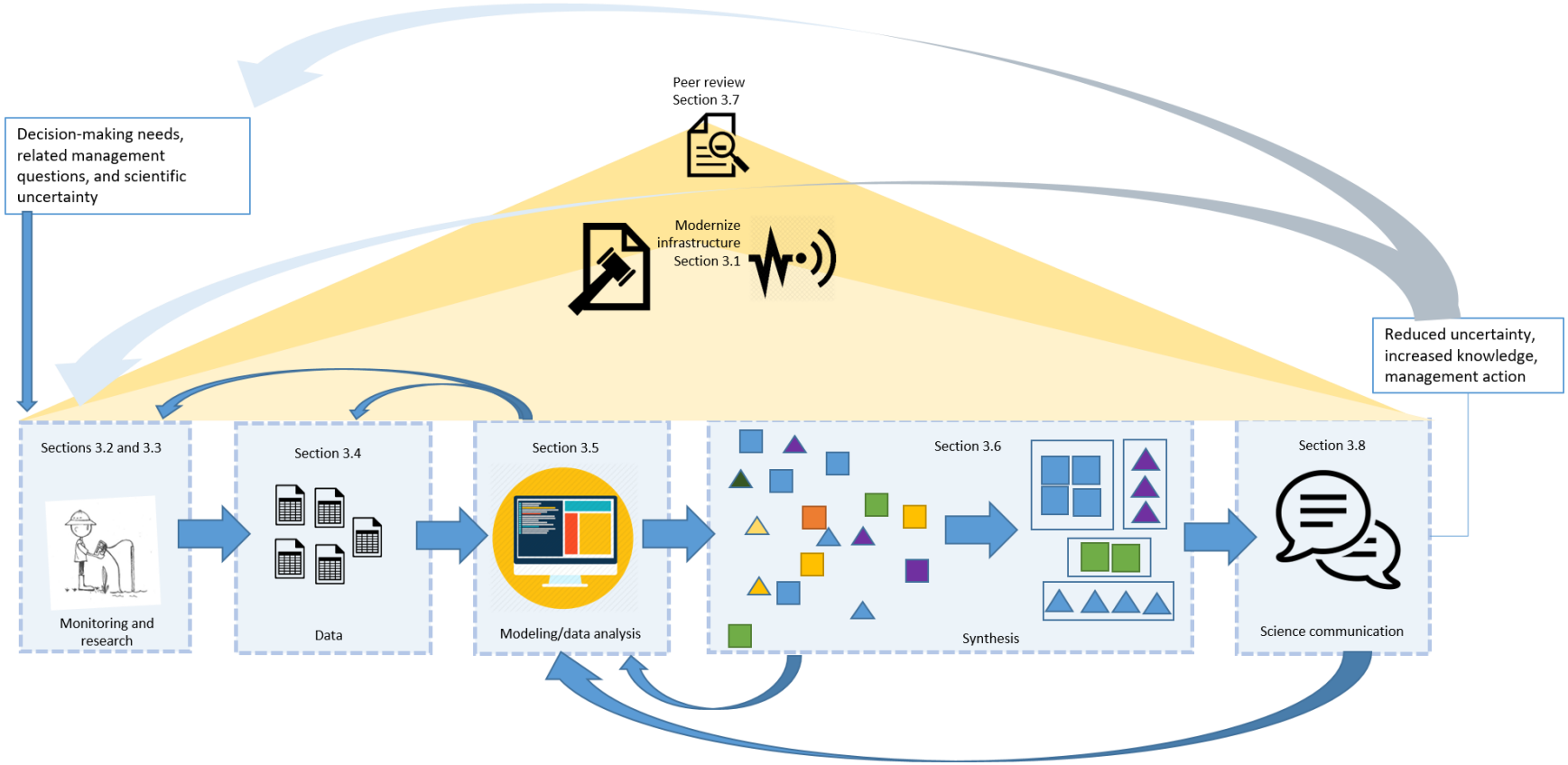


FIGURE 3-1. CONCEPTUAL RELATIONSHIPS OF THE MAJOR ELEMENTS OF SCIENCE INFRASTRUCTURE. ARROWS INDICATE THE FLOW OF INFORMATION FROM ONE ACTIVITY TO ANOTHER.

Modernize science infrastructure to meet current and future needs

Problem Statement

The science and management landscape of the Delta is continuously evolving and becoming increasingly complex. Many changes are driven by global factors such as climate change and are occurring at an increased pace, requiring rapid advances in how we collect and analyze information about the environment. Although progress has been made in developing innovative tools and learning from systems outside the Delta (DSC, 2016), additional steps are needed to explore cutting edge technology and new methods. There is also a need to better articulate the role of updated methods in improving both monitoring for regulatory compliance and research to address management needs. In addition, there is a growing recognition that socio-economic and political environments are critical factors that affect and are affected by resource management actions. Improved understanding of the linkages between social and ecological systems is critical for effective decision-making.

Actions to Support the Need

3.1 Host a summit to identify opportunities to utilize emerging technology

Host a summit to introduce new frontiers for advancing science in the Delta community. This summit should involve international experts and demonstrate the value of incorporating emerging technology and techniques in research and monitoring, such as wireless sensors, remote sampling technologies including drones, machine learning[18], artificial intelligence, and the internet of things.[19] Information generated at the summit will support initiatives linked to Assembly Bill 1755 (the Open and Transparent Water Data Act), innovations in knowledge discovery and management, and developing paths for enhancing current efforts in research and monitoring.

Primary responsibility: Delta Science Program, California Natural Resources Agency, California Department of Water Resources, California Water Quality Monitoring Council , California Technology Agency, State Water Resources Control Board

Action participants: Delta Conservancy, US Geological Survey, Interagency Ecological Program, Collaborative Adaptive Management Team, National Aeronautics and Space Administration Jet Propulsion Laboratory, California Council of Science & Technology; other federal, State, and local agencies and programs are responsible for managing environmental data and advancing knowledge discovery; representatives from universities, consultants, and non-government organizations

3.2 Establish a social science task force and a strategy to nurture and integrate social science research in the Delta.

Establish a social science task force with the goal of developing a strategy document with recommendations that can be used by the Delta science community to nurture social science research and strengthen its integration with the natural sciences. The strategy will also include recommendations to improve broader communication of science (see actions 3.14 and 3.15) and to promote effective science and management exchanges. These recommendations should be used to inform future competitive research solicitations, inform agencies' and programs' strategic plans and guide future updates of the Delta Science Plan.

[18] Machine learning is a method to teach computers to identify patterns from data and make decisions rather than relying on a predetermined equation. The decision performance (such as predictive ability) improves as the amount of data fed into the computer increases and expands the pool to "learn" from (Wright et al. 2016).

[19] The internet of things is the network of physical devices, vehicles, home appliances and other items embedded with electronics, software, sensors, actuators, and connectivity which enables these things to connect and exchange data, creating opportunities for more direct integration of the physical world into computer-based systems, resulting in efficiency improvements, economic benefits and reduced human intervention (Wright et al., 2016)

Primary responsibility: Delta Science Program, key interest groups involved in or working on Delta issues

Action participants: Delta Protection Commission, Delta Conservancy, Interagency Ecological Program, Collaborative Adaptive Management Team, Delta Independent Science Board, Delta Plan Interagency Implementation Committee, and other policy and management leaders in the Delta

EXPECTED OUTCOMES

- Timely integration of emerging technologies to access and assimilate real-time data and drive models
- Improved social science integration into decision-making about the Delta
- Increased social science knowledge that contributes to a greater understanding of cultural, recreational, and agricultural values of the Delta
- Robust transdisciplinary research programs to support decision-making about the Delta as a social-ecological system

Enhance and integrate the monitoring enterprise

PROBLEM STATEMENT

In the Delta, environmental monitoring[20], which most often is required for regulatory compliance, contributes information on a wide range of management topics from water flow, land use, and contaminants, to recreation and fisheries. However, many existing monitoring programs are not designed in a way that efficiently captures the comprehensive suite of information needed for Delta water and ecosystem management decisions—coordination across programs is often still lacking. Funding for effective adaptation and coordination of these programs is inadequate, especially for long-term programs. Long-term monitoring provides critical information necessary for distinguishing long-term trends from short-term variability (Cloern 2018). These insights can help decision-makers make current management decisions and better prepare for issues on the horizon, such as sea-level rise and other climate change-related effects. Monitoring programs also need to include social characteristics of the Delta, which help to provide insight on risk, habitat, and sense of place (Delta ISB, 2017b); these elements are rarely required for regulatory compliance or to track investment outcomes.

Efforts to Build On:

- California Water Quality Monitoring Council
- Interagency Ecological Program
- Delta Regional Monitoring Program
- San Francisco Bay Regional Monitoring Program
- Surface Water Ambient Monitoring Program
- Wetland and Riparian Area Monitoring Plan
- Delta Independent Science Board review of the Delta Monitoring Enterprise
- Delta Independent Science Board review of water quality science in the Delta
- Sacramento and Central Valley Chinook Salmon monitoring efforts

In addition to coordinating monitoring programs within the Delta, strategies to integrate with monitoring networks in the watersheds and the San Francisco Bay will be critical for a holistic assessment of the Delta. The Delta is not an isolated system and connects both physically and ecologically to a wide geographic range extending from the headwaters of the Sierra Nevada to the Pacific Ocean. While a statewide strategy for water quality monitoring (CWQMC, 2010)and select system-wide efforts such as salmon monitoring and modeling exist (Windell et al. 2017), there is still a need for a more focused and shared strategy for the Delta. This strategy should integrate the various programs both within and outside the region to address ecosystem and water management needs.

[20] The term "monitoring" covers a wide variety of sampling, analysis, measurement, and survey activities that reveal ecological, physical, social, and economic conditions and trends.

ACTION TO ADDRESS THE NEED

3.3 Develop a strategy that identifies current monitoring needs and facilitates monitoring program integration

Develop a strategy that provides standard protocols for data collection and sampling design, shared protocols to facilitate program integration (e.g., co-locating instruments and data sharing), mechanisms to maintain feedback loops between data users and data collectors to ensure relevant data are being collected, and approaches for maintaining and updating current programs. With respect to updating current programs, the trade-offs associated with having consistent long-term datasets versus having the most relevant information should be considered during the decision-making process. The strategy should incorporate the different elements of science infrastructure described in this chapter including modernizing technology (action 3.1), data sharing (actions 3.5 to 3.7), and communication (actions 3.14 and 3.15). The development of this strategy should build on the ongoing review that the Delta Independent Science Board is completing of the Delta monitoring enterprise.

Primary responsibility: Interagency Ecological Program, Delta Regional Monitoring Program, California Water Quality Monitoring Council and its workgroups, Delta Independent Science Board

Action participants: Delta Science Program, program directors and staff involved in collecting data for statewide, regional, and local monitoring programs

EXPECTED OUTCOMES

- Development of a collaborative and comprehensive monitoring science strategy that improves coordination between the Delta and San Francisco Bay
- Filling in of high-priority process information gaps through improved monitoring integration
- Efficient use of resources for monitoring science
- Improved availability and quality of data for use in regulatory oversight, adaptive management, assessing outcomes of water quality protection, natural resource management, and habitat restoration actions

Support research

PROBLEM STATEMENT

Scientific research provides the basis for a large portion of knowledge in the Delta. Research activities exist along a gradient from those that address current management problems to investigations that identify future uncertainties that are not of immediate concern. There is a need to support and maintain science activities that span this entire spectrum in the Delta to support both current and future management issues. However, current research efforts in the Delta are inadequately funded and lack coordination, generating information that is not sufficient for decision-making. Coordinated funding strategies to implement actions in the Delta Science Plan are discussed further in Chapter 5, and these mechanisms should be used to support ongoing and future research. Adopting shared processes for funding to address a range of science needs such as those discussed in Chapter 5 will also help streamline project implementation.

ACTION TO ADDRESS THE NEED

3.4 Establish a balanced portfolio of research funding programs and mechanisms in the Delta

Where possible, use the funding strategies developed from actions in Chapter 5 and Appendix J (e.g., through regular competitive research grant solicitations and Delta science fellowship solicitations) to provide sustainable funding for science. Support should be provided to research that addresses both immediate management needs and explores emerging issues and new technologies, which may be risky to implement but, could have a substantial impact on the current state of scientific knowledge.

Primary responsibility: Delta Science Program, California Department of Fish and Wildlife, Delta Conservancy

Action participants: Interagency Ecological Program and other science programs of federal, State, local agencies, and non-governmental organizations

EXPECTED OUTCOMES

- Expanded capacity to conduct high-priority and anticipatory research to meet decision-makers' needs
- Advances in new scientific discoveries and understanding of the Delta

Improve the organization and accessibility of scientific information

PROBLEM STATEMENT

The 2013 Delta Science Plan recognized the need for improvements in data[21] management infrastructure and mechanisms to facilitate data sharing and analysis. A summit was convened in 2014 to identify data sharing needs and the ensuing report B.K Williams, R.C Szaro, and C.D Shapiro, Adaptive Management: The U.S. Department of the Interior Technical Guide (Washington, DC: Adaptive Management Working Group, U.S. Department of the Interior, 2009), https://www2.usgs.gov/sdc/doc/DOI- AdaptiveManagementTechGuide.pdf.[22] served as a foundational document for the development of Assembly Bill 1755, or the Open and Transparent Water Data Act (Data Act).[23] Although the Data Act is an important step in improving data accessibility[24], there are other elements of the data life cycle outside its scope (e.g., data collection, storage, and interpretation) that can affect whether published data will yield useful and useable information[25] to support management actions (Figure 3-2).

Efforts to Build On:

- Regional Data Centers
- California Environmental Data Exchange Network
- EcoAtlas
- Bay Delta Live
- Surface Water Ambient Monitoring Plan standardized methods
- Water Quality Monitoring Council, My Water Quality portals
- San Francisco Estuary and Watershed Sciences Journal

Beyond data access, challenges remain with obtaining scientific information across other formats, such as journal articles, software, and other proprietary technologies. Access to this information and technology is critical to ensure that the most relevant and timely information and tools are used for synthesis and decision-making.

[21] Data is defined in this document as recorded symbols (e.g., words, numbers, and images) and sensory readings that capture a set of facts about an event Wiens et al., "Facilitating Adaptive Management in California's Sacramento–San Joaquin Delta.". Examples include measures of precipitation, flow, and population abundance.

[22] The data summit and white paper fulfil actions 4.3.1 and 4.3.2 of the 2013 Delta Science Plan, respectively.

[23] Assembly Bill 1755, passed in 2016, requires the Department of Water Resources, in consultation with the California Water Quality Monitoring Council, the State Water Resources Control Board, and the California Department of Fish and Wildlife, to "create, operate, and maintain a statewide integrated water data platform; and to develop protocols for data sharing, documentation, quality control, public access, and promotion of open-source platforms and decision-support tools related to water data."

[24] By "accessible", the information is not only easily obtainable but the availability of the information is widely known, and the user is able to understand what the information means.

[25] Information is a message with relevant meaning used to make decisions, solve problems, or realize an opportunity. Information can come from processes data but can also come from other forms of communication such as instructions Wiens et al., "Facilitating Adaptive Management in California's Sacramento–San Joaquin Delta"; Blaine D. Ebberts et al., "Estuary Ecosystem Restoration: Implementing and Institutionalizing Adaptive Management," *Restoration Ecology* 26, no. 2 (March 2018): 360–69, https://doi.org/10.1111/rec.12562..

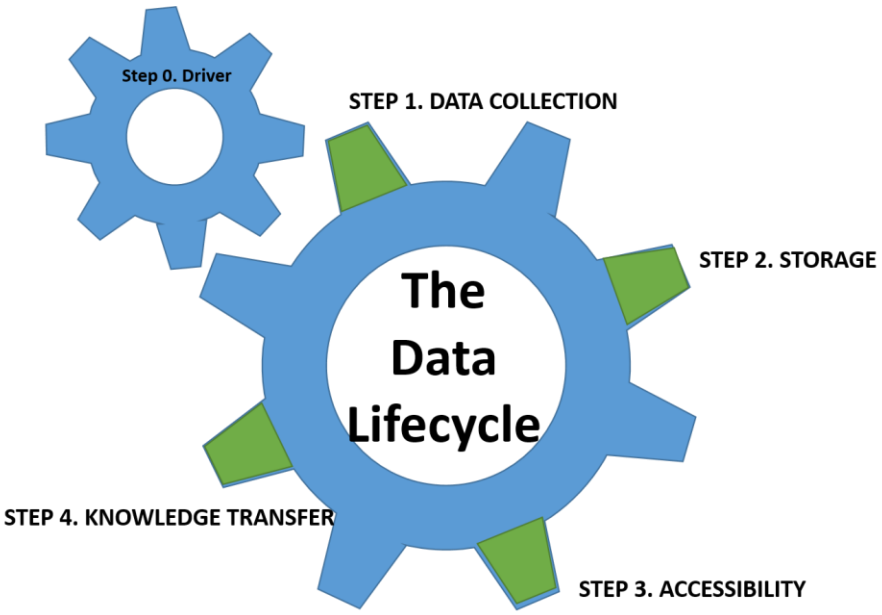


FIGURE 3-2. MAJOR STEPS INVOLVED THE DATA LIFE CYCLE[26]. DRIVER: A MANAGEMENT ACTION OR HYPOTHESIS THAT SPURS COLLECTION OF DATA TO ADDRESS THE NEED. DATA COLLECTION: HOW DATA ARE COLLECTED (E.G., NUMBER OF SAMPLES, LOCATION, QUALITY OF DATA). COLLECTION METHODS MAY CHANGE OVER TIME TO ADDRESS THE SAME DRIVER; CARE SHOULD BE TAKEN TO ENSURE THE EMERGING INFORMATION IS STILL RELEVANT. STORAGE: HOW THE DATA ARE STORED AND PROCESSED INCLUDING DOCUMENTATION AND QUALITY CONTROL AND ANALYSIS. ACCESSIBILITY (AB 1755 FOCUS): HOW ACCESSIBLE THE DATA ARE TO EXTERNAL USERS TO PROVIDE INFORMATION FOR VARIOUS PURPOSES INCLUDING DECISION-MAKING AND LEARNING. KNOWLEDGE TRANSFER: WHERE THE DATA AND INFORMATION ARE USED AND HOW THIS INFORMATION IS BEING COMMUNICATED TO FURTHER KNOWLEDGE. EXAMPLES INCLUDE INTERACTIVE MAPS, GRAPHS, AND DASHBOARDS.

ACTIONS TO SUPPORT THE NEED

3.5 Develop a shared framework that holistically addresses the data lifecycle to support the goals of Assembly Bill 1755

Collaboratively establish a framework that incorporates common standards and protocols for data collection, data quality assessment, data storage, and data access so that data available through the planned Assembly Bill 1755 federated platform[27] will be useful in supporting regulatory and management decisions.

Primary responsibility: Agencies and organizations involved in supporting Assembly Bill 1755 (e.g. Department of Water Resources, State Water Resources Control Board, Department of Fish and Wildlife)

Action participants: Delta Science Program, data users and generators from State, federal, local agencies, programs responsible for managing environmental data related to the Delta, representatives from universities, consultants, non-governmental organizations, and invited experts in the field of data management

3.6 Continue and enhance support for existing web-based data systems including those currently outside the scope of AB 1755

Ensure existing online databases and web-based data storage systems that contribute to the federated platform are well maintained and routinely updated to meet user needs. Develop strategies to improve both the visibility and accessibility of other web-based systems that support decision-making in the Delta (e.g.,

[26] Gearhart, 2018 personal communication
[27] A centralized system that gathers multiple data repositories. The source databases remain unmodified.

datasets hosted by the Office of Emergency Services, Reclamation Districts, diverters, and growers). Strategies should consider benefits and mechanisms of incorporating these databases into the federated AB 1755 platform.

Primary responsibility: California Water Quality Monitoring Council, Department of Water Resources, State Water Resources Control Board, San Francisco Estuary Institute, Delta Science Program

Action participants: Agencies primarily responsible for supporting Assembly Bill 1755, Reclamation districts, Delta diverters, Delta farm cooperatives, Office of Emergency Services

3.7 Promote accessibility to peer reviewed scientific literature, data, and tools

Develop strategies to improve access to the latest scientific information for agency scientists. Incorporate strategies to enhance data and information availability and timely public access to data and software. Ensure reports for all research funded by the State include requirements and incentives (e.g., additional funds) in State grants for open-source[28] licensing and publishing in open journals.

Primary responsibility: Delta Science Program, California Department of Fish and Wildlife, Delta Conservancy, agencies and entities with active research grant programs

Action participants: Central Valley Flood Protection Board, California Department of Water Resources, US Bureau of Reclamation, US Geological Survey, US Fish and Wildlife Service, and Academia

Expected outcomes

- Enhanced data sharing among agencies, institutions, and other disciplines
- Community data access, integration, analysis, and visualization
- Open access to data for agencies, scientists, stakeholders, and citizen scientists (including K-12 schools)
- Improved usability of data in supporting regulatory and management decisions
- Improved access to scientific literature for Delta scientists

Build a collaborative modeling community

Problem statement

Models are a central part of understanding how the Delta functions as a dynamic system. They contribute information towards synthesis efforts (see next section), are key components in the design, adaptive management (see chapter 4), performance assessment of projects and actions, and are integral in identifying and evaluating the trade-offs between alternative future scenarios. Given the complex nature of the Delta, no single agency has the capability or capacity to develop the models and modeling networks to assess management decisions across the Delta. Currently, model development, application, and analysis takes place at multiple agencies, academic institutions, and private entities, but with little coordination. In some cases, separate divisions with little communication between members of the modeling community conduct different stages of individual models. This fragmented approach results in a lack of transparency in how models are applied (e.g., what kinds of scenarios were considered, underlying assumptions, what datasets were used),

Efforts to Build On:

- California Water and Environmental Modeling Forum
- Integrated Modeling Steering Committee
- Chesapeake Bay Modeling Workgroup
- Louisiana Coastal Master Plan Modeling

[28] Open source is any software, project, products, that people can inspect, modify, enhance, and share because its design is publically accessible (https://opensource.com/resources/what-open-source)

unnecessary duplication of efforts, and a lack of understanding among managers and stakeholders regarding model outputs. These factors ultimately promote mistrust of models and conflict over conclusions, rather than support for the application of models in the Delta (Medellín-Azuara et al. 2017). There is a need for more

Box 3-1. Examples of successful community modeling efforts

The Chesapeake Bay Program Modeling Workgroup provides the Chesapeake Bay Partnership (CBP) with "state-of-the-art decision-support modeling tools that are built through community and participatory principles." These principles include integrating and applying the best available science to support independence, embracing innovation, and committing to an open and transparent process. "[The] integrated models assess effects of current and proposed watershed management on changes in nutrient and sediment loads delivered to the Bay, and the effect those changing loads have on water quality and living resources. The CBP models assist CBP decision-makers in estimating the collective actions needed to achieve State and federal water quality standards necessary to restore the Bay. https://www.chesapeakebay.net/who/group/modeling_team

collaborative[29] approaches with a focus on integrated modeling[30] to leverage technical expertise and resources of participating groups and to promote open information sharing (DSC, 2016), similar to collaborative efforts in other regions, such as the Chesapeake Bay Modeling Workgroup (Box 3-1).

Actions to Address the Need

3.8 Develop a strategy to grow the collaborative modeling community

Building on current efforts of the recently established Integrated Modeling Steering Committee,[31] develop a strategy that details the critical mechanisms and components of a collaborative and integrated approach to modeling in the Delta (Figure 3-3). The objectives of the strategy should be to facilitate integration of existing physical, biological, and social models and to improve communication to decision makers of model capabilities and outputs. Components of the strategy should include data sharing protocols to ensure transparency, strategies to improve communication between modelers of different disciplines and between modelers and data users to facilitate translation of information and needs, and approaches to objectively compare and evaluate methods and outputs to support product robustness. The strategy should also address how to improve access for community use of shared modeling tools, as well as incorporate other elements of the science infrastructure identified in this document including support for open data (actions 3.5 to 3.7) and frequent outreach and engagement with the public (actions 3.14 and 3.15).

Primary responsibility: Integrated Modeling Steering Committee, California Water and Environmental Modeling Forum, Delta Science Program

[29] Collaborative modeling" means the modeling community comes together to jointly identify issues and work towards developing tools to address these issues using an iterative process that involves effective communication at all levels (Hanak et al., 2012; Medellín-Azuara et al., 2017).

[30] Integrated modeling involves linking models that represent different parts of a system (e.g. physical, social, biological), allows for a more holistic understanding and provides insights on how an action can have potential cascading effects on other elements of the system William J. Sutherland and Harry J. Woodroof, "The Need for Environmental Horizon Scanning," *Trends in Ecology & Evolution* 24, no. 10 (October 2009): 523–27, https://doi.org/10.1016/j.tree.2009.04.008..

[31] The Integrated Modeling Steering Committee was established in response to the need for a collaborative modeling community and the use of integrated models in the Delta. The Integrated Modeling Steering Committee charge is to develop a detailed strategy and plan for integrating Delta ecosystem modeling that will incorporate model developers and model users to support the collaboration and communication needed make use of models for decision-making in the Delta.

Action participants: Department of Water Resources, State Water Resources Control Board, Collaborative, Adaptive Management Team, Interagency Ecological Program, Delta Plan Interagency Implementation Committee, federal, State, local agencies, academics, and consultants

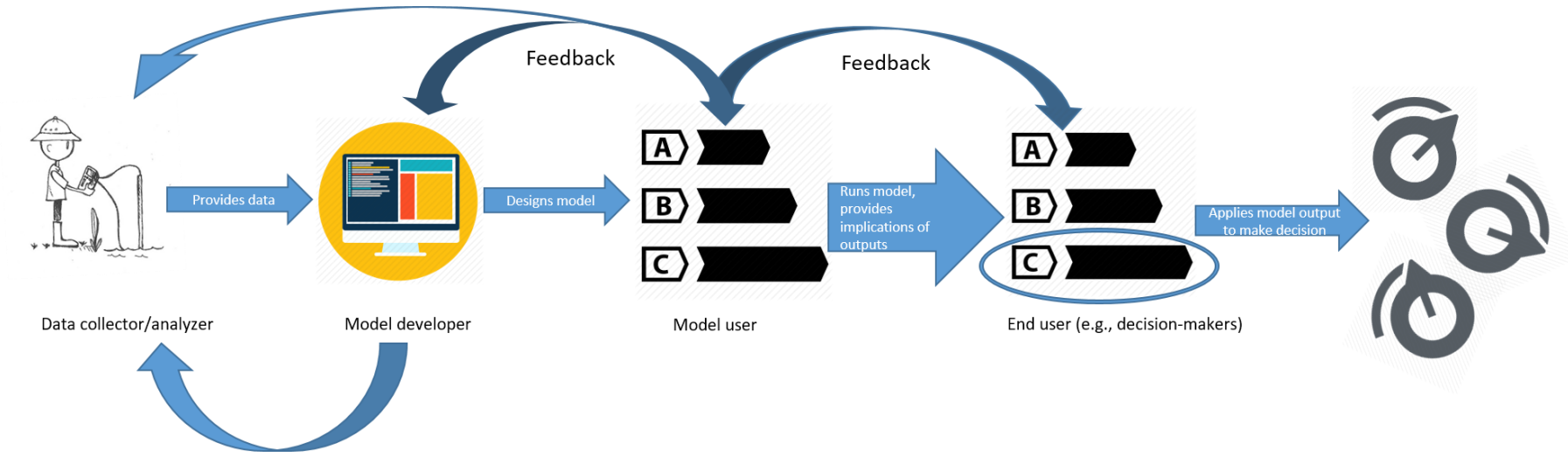


FIGURE 3-3. COLLABORATIVE MODELING COMMUNITY CONCEPTUAL MODEL. IN ADDITION TO COMMUNICATION BETWEEN GROUPS ASSOCIATED WITH THE DIFFERENT STEPS, COMMUNICATION WITHIN EACH OF THESE GROUP IS CRITICAL TO STRENGTHEN COORDINATION AND REDUCE REDUNDANCIES.

3.9 Support high-priority model development

Support high-priority[32] model development and refinement through research grants, fellowships, workshops, seminars, and conferences. Foster the development of inter-institutional and interdisciplinary clusters of scientists around model themes (CASCaDE project[33]) and ensure a continuity of support for these initiatives to sustain model development and technical support to the scientific community.

Primary responsibility: Delta Science Program, California Water and Environmental Monitoring Forum, Integrated Modeling Steering Committee

Action participants: Department of Water Resources, Collaborative Adaptive Management Team, Interagency Ecological Program, State Water Resources Control Board, academics, and consultants

EXPECTED OUTCOMES

- Improved awareness and understanding of the utility of modeling efforts to inform management decisions
- Enhanced collaboration among modelers, including shared input data, shared scenarios and results, and improved data transfer between models
- Improved efficiencies for model development and application, increasing the availability of modeling resources for synthesis, information transfer, and model improvement

Guide and support synthesis for system-wide perspectives

PROBLEM STATEMENT

Efforts to Build On:

- The State of Bay-Delta Science 2016
- IEP Management Analysis and Synthesis Team
- Synthesis products in *San Francisco Estuary and Watershed Science*
- National Center for Ecological Analysis and Synthesis model
- Delta Science Program synthesis efforts

The National Research Council identified synthesis as the single most important need for developing Delta science and identifying the likely consequences of management actions (NRC, 2011). Scientific synthesis is the act of bringing together complex sets of information that are often scattered among various repositories, reports, and journals, and integrating this information to yield new knowledge, insights, and explanations (Carpenter et al. 2009; Peters 2010). Accessible data and robust modeling tools are important components of comprehensive synthesis efforts (see actions 3.14 and 3.15). A tremendous amount of scientific information exists in the Delta across a broad range of fields and no single agency has the capacity to bring this massive amount of information together. Presently, no coordinated strategy exists to leverage the range of expertise and resources for conducting synthesis efforts across agencies. Resources for synthesis are also lacking for State scientists—oftentimes staff work outside their allocated working hours to contribute to synthesis. This lack of coordination and dedicated staff time has contributed to missed opportunities to inform management actions.

[32] Models used to answer immediate management questions that need to be addressed in the short term (1-2 years) or models that have been collectively identified as important and necessary to develop in the short term.

[33] Computational Assessments of Scenarios of Change for the Delta Ecosystem is a research project to develop and apply a model=based approach of ecological forecasting to project future states of the Delta ecosystem, and to communicate the outcomes to resource managers. The objectives of this project are to develop and verify a set of models of climate, watershed hydrology, sediments, and water quality, and link these models to forecast how the Delta ecosystem will change.

Moreover, many of the synthesis products that do exist in the Delta tend to be technical and lengthy. While this format may be helpful for scientists and experts, it is not accessible to most decision-makers. Technical synthesis reports need to be translated into more useable formats such as policy-briefs and fact sheets to disseminate the outcomes and implications of the synthesis product to decision-makers and the public. There is a need for a shared set of processes and protocols to guide synthesis efforts so they are scientifically rigorous, transparent, and engage end users (e.g., decision-makers and stakeholders) early to ensure the information provided is relevant and useable (Tranfield et al., 2003; Lomas 2005; Neal, et al., 2014).

ACTIONS TO ADDRESS THE NEED

3.10 Establish a shared set of best practices and protocols for focused synthesis

Collaboratively develop best practices and processes for focused synthesis as a guide to accelerate understanding of the Delta, manage scientific conflict, and support policy and management decisions. Key aspects should include formalized engagement with stakeholders and decision-makers ensuring products are useable and timely—along with shared strategies for collecting, refining, writing, and communicating the information.[34] For an example of a protocol used by the Delta Science Program to conduct independent scientific synthesis workshops, see Appendix E.

Primary responsibility: Delta Science Program, Interagency Ecological Program, and the Collaborative Adaptive Management Team

Action participants: Other federal, State, and local agencies, and the Delta Regional Monitoring Program

3.11 Support opportunities that foster synthetic thinking throughout the Delta science and management communities

Provide opportunities for Delta scientists to learn appropriate methods for conducting synthesis and exchange that enables partnerships to work on future synthesis projects. These can include conferences, training workshops, and work group meetings.

Primary responsibility: Agencies and entities involved in developing synthesis products (e.g. Delta Science Program, Interagency Ecological Program Management Analysis and Synthesis Team, and the Collaborative Adaptive Management Team)

Action participants: Interagency Ecological Program, Delta Regional Monitoring Program, State Water Resources Control Board, other federal, State, and local agencies; academic institutions, and California Sea Grant

3.12 Increase resources to conduct synthesis

Encourage collaborative synthesis efforts among agencies, such as those conducted by the Interagency Ecological Program's Management, Analysis, and Synthesis Team to leverage existing resources. Formally provide staff scientists with the time to work on synthesis projects as part of their job statement and work plan. Develop strategies to increase resources including language in solicitations that support synthesis projects.

Primary responsibility: Interagency Ecological Program, Collaborative Adaptive Management Team, Delta Science Program, state, and federal agencies

[34] One source that may provide useful examples is the guidelines for systematic synthesis developed by the Collaboration for Environmental Evidence http://www.environmentalevidence.org/information-for-authors

Action participants: Academia, stakeholder groups, and non-governmental organizations

Expected outcomes

- Production of diverse synthesis publications that are more relevant and readily understood by a broad range of audience members including decision-makers, scientists, and stakeholders
- A culture of interdisciplinary and collaborative scientific exploration that enhances the understanding of a dynamic system
- A better understanding about how the Delta may respond to future changes induced by management actions, climate change, natural disasters, and chronic stressors

Utilize independent scientific peer review and advice

Problem statement

Efforts to Build On:

- Delta Science Program policy and procedures for independent scientific review
- Delta Science Program policy and procedures for independent scientific advice
- National Academy of Science's review approach and role
- Delta Independent Science Board reviews

The peer review process has been used in the Delta to determine whether a project, program, or management effort has used the best available science. Well-designed peer review processes also provide independent perspectives and assessments from experts in the subject area. In the Delta, peer review by independent scientific experts plays an important role in increasing the credibility of scientific information and helps scientists improve the quality of their work. However, a standard level of peer review is not yet consistently applied in the Delta. The Delta Science Program has taken a leadership role in coordinating independent scientific reviews of proposals, processes, programs, plans, and products. The policy and procedures used by the Delta Science Program are included in Appendix F. To be most effective and maintain high-quality, peer review should be conducted in a way that is objective, rigorous, and transparent. This approach to peer review should be an integral and expected part of the science conducted in the Delta.

A companion to peer review is independent scientific advice (Appendix F). Projects and programs often benefit from the active participation of an independent scientist or scientists when they are faced with challenging technical or scientific issues. In these cases, an independent entity can help programs by identifying experts with experience in the appropriate disciplines who can provide advice at key points in planning, implementation, or evaluation. A summary comparison of independent peer review and advice is provided in

Table 3-1.

Action to support the need

3.13 Continue consistent application of scientific peer review and independent science advisors

Seek expansive support for the use of a well-defined, transparent, and widely accepted process for conducting scientific peer review and receiving independent scientific advice that is consistent across programs and can be applied to research, planning, and management documents in the Delta.

Primary responsibility: Delta Science Program

Action participants: state and federal agencies, stakeholders, collaborative groups, and academia

Expected outcomes

- Widely-used, transparent peer review and advice processes

- High quality scientific information that builds trust in decision-making processes

TABLE 3-1. COMPARATIVE DESCRIPTIONS OF INDEPENDENT SCIENTIFIC PEER REVIEW AND INDEPENDENT SCIENCE ADVISORS.

Science service	Purpose	Product	Examples
Independent scientific peer review (Appendix F)	Provide independent scientific review of a near-complete document or scientific product (e.g., plan, report, permit application, analyses, study design, or model). Reviews may include a public review panel meeting for high-profile topics and/or to increase transparency of the review effort.	Independent review panel or individual panelist review comments in report format.	Long-term Operations Biological Opinion Review, Bay Delta Conservation Plan Effects Analysis Review
Independent science advisors (Appendix G)	Provide independent scientific advice on early-draft documents or science-based products (e.g., models, study designs, analyses). Advice is generally iterative throughout the development of the draft products and the process may or may not include a public meeting.	Individual advisor or advisory panel recommendations in the form of informal memos and/or reports.	Six-Year Acoustic Tag Science Advisors

Support effective communication of scientific information

PROBLEM STATEMENT

Science communication plays an essential role in delivering pertinent information to scientists, decision-makers, stakeholders, and the general public in a timely manner. Both stakeholders and members of the public play key roles in marshaling political support and resources for science-related efforts. Effective science communication is thus imperative to increase the public's awareness and appreciation for the Delta's natural resources and multi-benefit ecological systems.

Efforts to Build On:

- Forming partnerships with museums, academia, and the media to showcase the Delta and increase public awareness around the State (LHC, 2005)
- Exploring digital communication technologies and increasing use of social media

In the Delta and elsewhere, important scientific information is often underutilized because it is not communicated effectively. A wide range of audiences exist having both technical and non-technical backgrounds that respond to different types of communication. In many cases the target audience may be too limited due to lack of insight regarding who may benefit from the information. Synthesis reports can be too technical for a broader audience, websites may be difficult to navigate, and many online tools meant for the public may not have adequate instruction or visibility. These factors can contribute to a lack of awareness by members of the public, including those that live in this region, of the ecological and economic importance of the Delta. A broad range of avenues exists for science communication including print and online venues, seminars, workshops, symposia, conferences, forums, social media, and other educational efforts (see Appendix H). A more widespread use of multiple science communication strategies in the Delta is needed even for a single issue or report so that scientists, decision-makers, stakeholders and the public are aware of the information.

ACTIONS TO SUPPORT THE NEED

3.14 Develop, compile, and share methods for science communication to leverage existing efforts

Establish a repository of science communication methods from agencies and entities involved with the Delta and beyond and make it accessible to the public. The goal of the repository is the compilation of different communication strategies for different audiences. This will allow individual groups to compare and adopt different communication methods to guide their science communication and information sharing strategies.

Primary responsibility: Delta Science Program

Action participants: Communication experts, federal, State, and local agencies, interagency groups (e.g. Interagency Ecological Program and California Water Quality Monitoring Council), academic science programs, other science programs, non-governmental organizations, and professional societies.

3.15 Support and enhance communication efforts and tools

Continue efforts such as symposia, brown bags and web outreach that bring together decision-makers, scientists, stakeholders, and the public to discuss current and future science and management issues in the Bay-Delta. Improve web-search visibility of communication resources and provide training to use interactive web-based visualization tools such as maps, graphs, portals, and dashboards. To ensure these tools and strategies are useful and to identify areas for improvement, create opportunities for community feedback on web applications, conferences, and other venues. These feedback outlets should include website-based comment boxes and surveys.

Primary responsibility: Delta Science Program, State Water Resources Control Board, and academic science programs

Action participants: Academic science programs, federal, State, local agencies, members of the public, private, and nonprofit organizations

3.16 Support opportunities for trainings that enhance science communication skills of Delta scientists

Encourage and provide opportunities for scientists and staff to attend science communication events such as trainings and workshops and to work closely with communication experts.

Primary responsibility: All science programs and divisions in the Delta

Action participants: All science programs in the Delta

EXPECTED OUTCOMES

- Better communication between scientists and decision-makers increasing awareness of the value of scientific information
- Increased ecosystem and water management decisions informed by the best, most up-to-date scientific information with an enhanced understanding of the management implications of scientific results
- A deeper appreciation of investment returns of funding science and the use of best available scientific information to guide policy decisions
- More instances of science-informed behaviors and decisions by the public resulting from increased availability of scientific information in accessible formats

CHAPTER 4. SUPPORT EFFECTIVE DECISION-MAKING THROUGH SCIENCE-BASED ADAPTIVE MANAGEMENT AND DECISION SUPPORT TOOLS

Adaptive management is a science-based strategy for making management decisions under uncertain conditions rather than delaying action until more information is available (Wiens et al. 2017). The process is a form of structured decision making[35] with a focus on continuous and iterative processes (Williams, Szaro, and Shapiro 2009). Integral to effective adaptive management is a high degree of coordination and collaboration, clear understanding of objectives, dedicated and formalized use of decision-support tools[36] including socio-ecological models, two-way communication between decision-makers, scientists, and stakeholders, and broad acceptance of the process (Wiens et al. 2017; Ebberts et al. 2018). The concept of adaptive management has been widely embraced, and many Delta planning and policy efforts have adopted adaptive management as the way forward for managing complex natural resources programs and projects. Figure 4-1 provides the nine-step adaptive management process outlined in the Delta Plan, while Box 4-1 provides examples of how science is integrated into each step.

This chapter focuses on advancing acquisition of new knowledge in water and ecosystem management through adaptive management. Successful implementations of the actions in this chapter rely on efforts that build on the structures and processes identified in chapters 2 and 3 including models and monitoring support.

[35] Structured decision-making is a systematic approach to understanding and assessing a set of problems. Management actions (alternatives) are explicitly linked to well-defined, quantifiable objectives through models that incorporate both these linkages and the underlying uncertainty associated with actions and responses. Structured decision-making adds transparency to the decision making processes in natural resource management by defining a repeatable process. In this way, stakeholders can see what steps are being taken to arrive at a decision. This process is particularly important when decisions lead to less desirable outcomes.

[36] Decision-support tools are approaches designed to facilitate making choices among actions that differentially achieve a set of potentially competing objectives. They are usually in the form of interactive software such as models and visualization tools Liew..

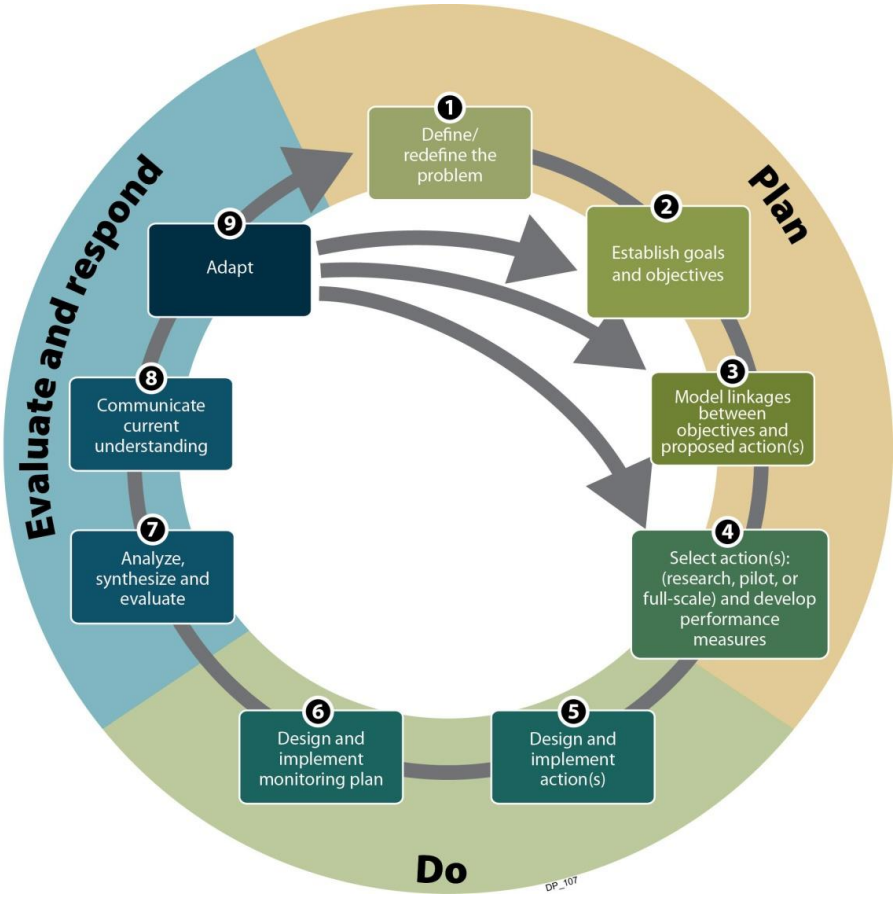


FIGURE 4-1. DELTA PLAN'S NINE-STEP ADAPTIVE MANAGEMENT FRAMEWORK. SEE BOX 4-1 FOR MORE DETAILS ON HOW EACH OF THESE STEPS ARE APPLIED TO SCIENCE-BASED ADAPTIVE MANAGEMENT.

Box 4-1. Role of science in adaptive management

1. Provide unbiased and objective evidence for identifying and defining problems.
2. Use conceptual models for establishing goals and objectives within spatial and temporal context, based on the latest science.
3. Use broadly accepted and transparent quantitative and/or conceptual models to identify critical uncertainties, develop hypotheses, model alternative actions, and identify data necessary to test hypotheses.
4. Evaluate alternative actions using information from models and decision support tools; verify and validate models; use models to develop performance measures.
5. Design/implement actions such that they test assumptions and reduce scientific uncertainties. Provide expert evaluation and peer review of project design.
6. Design and implement monitoring and data management consistent with system-wide efforts and Delta Science Plan recommendations.
7. Analyze data and models used, synthesize scientific information, and evaluate progress based on performance measures.
8. Communicate the state of knowledge in a manner that informs adaptive management decisions. The audience should include project decision-makers as well as the larger scientific and management communities.
9. Advise on selecting the next generation of follow-up actions. Consider all new scientific information, as well as how such actions fit within the context of landscape-scale plans and programs.

Problem Statement

Past attempts to manage Delta water and ecosystem resources adaptively have rarely covered the full adaptive management cycle and often have not considered the appropriate time frame and spatial scale required for changes to occur as a result of management actions. Challenges in implementing adaptive management include lack of resources, direction to support adaptive management, and the need for large-scale acceptance and implementation of the process (Wiens et al. 2017; Ebberts et al. 2018). Strategies are needed to more clearly define and integrate the roles and responsibilities of decision-makers, scientists, and stakeholders in adaptive management. Adaptive management approaches should be customized for different projects and decisions to reflect differences in time scales, geographic areas of the Delta, and water management and ecological issues (Wiens et al. 2017).

Actions to Address the Need

4.1 Implement adaptive management and structured decision-making approaches more consistently in natural resource management

Implement adaptive management approaches consistently and in an integrated and coordinated way across the various entities supporting adaptive management in the watershed (e.g., EcoRestore, Interagency Implementation and Coordination Group of the California WaterFix, the Collaborative Adaptive Management Team, and the Interagency Adaptive Management Integration Team). Incorporate experiments into ecosystem restoration and water management projects to test hypotheses and more effectively identify cause and effect benefits of potential actions (Wiens et al. 2017). Utilize the guidance documents currently under development to support science-based adaptive consistent with the Delta Plan's adaptive management framework[37]

Primary responsibility: Delta Science Program and Delta Stewardship Council Planning Division, EcoRestore Program, State, federal, and local agency staff involved in planning, funding, regulating, or implementing ecosystem restoration projects (including participants of the Interagency Adaptive Management Integration Team), Collaborative Science and Adaptive Management Program/Collaborative Adaptive Management Team participants

Action participants: Federal, State, local agencies, and organizations involved in planning and implementing adaptive management

4.2 Provide Adaptive Management Liaisons

Sustain Delta Science Program staff members with expertise in adaptive management and its application in Delta water management and ecosystem restoration projects. Adaptive Management Liaisons provide advice to agencies and organizations that are planning and implementing adaptive management, including but not limited to, Delta Plan covered actions (see Appendix I for more information on Adaptive Management Liaisons).

Primary responsibility: Delta Science Program

Action participants: Federal, State, local agencies, and organizations involved in planning and implementing adaptive management

4.3 Hold regular Adaptive Management Forums

Hold regular Adaptive Management Forums with national and international experts and local proponents to provide adaptive management training for a broad range of agency staff and build capacity for planning and

[37] Two documents currently being developed include the Interagency Adaptive Management Integration Team white paper and the Water Supply Reliability Adaptive Management Framework (developed by the Delta Science Program.

implementing adaptive management. These forums will provide a venue at which participants can discuss adaptive management approaches to ecosystem restoration and water management, share lessons learned from the Delta and elsewhere, and identify potential impediments to adaptive management activities.

Primary responsibility: Delta Science Program

Action participants: National and international experts on adaptive management, federal, State, local agencies, non-governmental organizations, private organizations, and academic institutions involved in successfully implementing adaptive management

Expected Outcomes

- Critical management uncertainties are addressed in an organized manner that accelerates shared learning and application to future management actions, resulting in a more efficient use of resources and more effective implementation of future water management and ecosystem restoration projects
- Individual adaptive management programs and plans have greater consistency, facilitate learning, integration of results, and evaluation of cumulative and system-wide benefits
- Increased use of experimentation, problem formulation, and continuous learning to address management uncertainties

CHAPTER 5. COLLECTIVELY SUPPORT IMPLEMENTATION OF THE DELTA SCIENCE PLAN

Collective action by the Delta science community is necessary to achieve the vision of *One Delta, One Science.* The multiple, often conflicting, management goals in the Delta cannot be met by a single agency or entity. The key players in the Delta science enterprise must work together to develop effective, science-based approaches to address these challenges. This chapter identifies processes and strategies to promote joint implementation of the Delta Science Plan. Successful implementation requires sustainable financial resources, strong leadership, and a technically competent workforce to carry out the initiatives identified in this document.

Efforts to Build On:

- Communication and funding strategies employed by:
  - Comprehensive Everglades Restoration Program
  - Chesapeake Bay Program
  - National Estuaries Program
  - Laser Interferometer Gravitational-Wave Observatory
  - National Ecological Observatory Network

Identify and cultivate resources to support integrated science actions and science infrastructure

Problem Statement

Although the Delta Plan calls for the Delta Science Plan, it does not identify a source of support to implement the actions. The Delta science community will need to come together and speak with one voice to develop a case for dedicated continuous funding and to engage political leaders to champion institutional change and spark further collective action. This will require clear documentation of current allocations of science funding to effectively justify the need for increased financial resources for Delta science activities.

Although both the Delta Science Plan and the Science Action Agenda provide the principles for collaborative science, the Delta science community recognizes the importance of identifying more specific science priorities and creating coordinated and detailed implementation plans for more specific Delta science activities that nest within the broad vision of these guiding documents. Efforts have been underway to develop implementation plans for some science topics; however, resources for development and coordination of these plans are lacking.

Strong leadership is critical for marshalling these resources and shepherding collaborative efforts and of equal importance are the individuals who carry out the initiatives identified in the Delta Science Plan. Despite this recognized importance, the State has struggled in both recruiting and retaining skilled individuals with technical backgrounds. These staffing needs are compounded by the wave of retirements in recent years, which are expected to continue. Currently, there are no widely-accepted mechanisms to maintain institutional knowledge and document best practices, which are often lost as senior staff retire. This is a critical issue especially in the Delta where historical knowledge plays an important role in navigating the nuances of the socio-ecological network and avoiding duplicative efforts and inefficiencies. There is a need for innovative approaches to address staffing challenges and to provide opportunities for current employees to grow and maintain their technical expertise to continue the momentum to support long-term science efforts.

Actions to Address the Need

5.1 Establish shared mechanisms and processes for efficient funding

Develop a shared set of funding approaches to enhance existing financial resources and how efficiently they are used to support Delta science. These shared approaches should include effective communication and

articulation of science benefits to garner more consistent funding. Appendix J provides potential strategies to leverage existing resources and to identify additional sources of funding, while Appendices K and L provide examples of funding processes used by the Delta Science Program and conflict of interest policies.

Primary responsibility: Delta Agency Science Workgroup

Action participants: Delta Science Program, Delta Plan Interagency Implementation Committee

5.2 Facilitate development and coordination of topic-specific Delta science implementation plans

Coordinate workgroups to draft more detailed topic-specific science implementation plans based on the Science Action Agenda and the State of Bay-Delta Science. Implementation plans will identify specific priority science actions based on existing efforts and needs for individual topics (e.g., Delta Smelt Resiliency Strategy, Sacramento Valley Salmon Resiliency Strategy, recent efforts around primary productivity and nutrient management issues, and on-going efforts of the Interagency Ecological Program and the Collaborative Adaptive Management Team). Development of these plans will identify science funding needs based on specific recommendations of priority actions.

Primary responsibility: Delta Agency Science Workgroup

Action participants: Delta Science Program, Natural Resources Agency, Delta Plan Interagency Implementation Committee, Collaborative Adaptive Management Team, State legislature, management level and staff level members from the Sacramento-San Joaquin Delta Conservancy, Interagency Ecological Program, and other State and federal agencies with interests in developing a strategy for increased science funding

5.3 Develop a web-based tracking system of science activities in the Delta

Develop a comprehensive internet-based science project-tracking tool that provides a mechanism to efficiently assess financial investments and science activities. This web-based tracking tool will catalog information that can be used by scientists, stakeholders, and the public to identify additional opportunities for coordination and collaboration and serve as a valuable tool to aid decisions about policy and funding.

Primary responsibility: Delta Science Program

Action participants: Interagency Ecological Program, California Water Quality Monitoring Council, Sacramento Regional County Sanitation District, and other science programs of federal, State, and local agencies

5.4 Maintain and grow the scientific expertise workforce needed to support Delta Science Plan implementation

Establish shared processes and mechanisms to provide Delta scientists with opportunities for professional development, enhancing leadership and communication skills, networking, and access to the latest scientific information. These include improving access to scientific journals, analytical resources, and modeling tools, building relationships across science sectors, and facilitating attendance at scientific seminars, conferences, and symposia. Succession management plans should be developed to maintain institutional knowledge including ongoing training, regular documentation of lessons learned, and opportunities for junior staff to purposefully interact with and learn from their senior colleagues (CalEPA, 2007).

Primary responsibility: Delta Science Program, Collaborative Adaptive Management Team, and the Delta Plan Interagency Implementation Committee

Action participants: Federal and State agency directors, State legislature, Department of Finance, Delta Independent Science Board, stakeholders, and entities with an interest in the science of the Delta

EXPECTED OUTCOMES

- Increased capacity to support and conduct high-priority research and to address questions beyond limited mandates of individual agencies
- Better informed decisions for resource management
- Improved coordination and transparency of science activities
- Improved recruitment and long-term employment of high-quality Delta scientists

Assess Delta Science Plan performance

PROBLEM STATEMENT

Performance measures allow for reflection on the achievements of a program or initiative. Communicating these achievements in turn demonstrate to the public and stakeholders where steps are being taken to ensure resource alignment and coordination. Currently, there are no performance metrics or mechanisms to track Delta Science Plan implementation and outcomes. Performance measures of the Delta Science Plan will provide a reflection of how implementing the actions in the document has improved the development, organization, and communication of science in the Delta; how the collective accomplishments of each chapter contribute to achieving the six overarching goals, and guidance for where improvements can be made.

ACTIONS TO ADDRESS THE NEED

5.5 Develop and report performance measures for the Delta Science Plan

Evaluate performance of the Delta Science Plan in meeting the six objectives to achieve the vision of *One Delta, One Science.* These include strengthening the science-management interface, coordinating and integrating Delta science in a transparent manner, enabling and promoting science synthesis, managing scientific conflict, supporting effective adaptive management, and maintaining and advancing understanding about the Delta. Performance assessments will be communicated as a narrative in updates to the Delta Science Plan. Progress on the actions in each chapter and identified outcomes will be evaluated through conducting surveys and interviews with individuals and collaborative science groups to assess the sense of progress achieved by the Science Plan.

Primary responsibility: Delta Science Program

Action participants: Delta Agency Science Workgroup and other users of the Delta Science Plan (state and federal agencies, Delta science community)

EXPECTED OUTCOMES

- Transparent reporting of Delta Science Plan implementation progress based on performance evaluations and identification of areas that can be improved

GLOSSARY

Accessibility - The ability to obtain data (e.g., digital access, phone application) and the extent to which the information is understandable and useable by the user.

Action participants - Agencies, other groups, and individuals involved in carrying out actions identified in the Delta Science Plan and Science Action Agenda.

Adaptive management - A framework and flexible decision-making process for ongoing knowledge acquisition, monitoring, and evaluation leading to continuous improvement in management planning and implementation of a project to achieve specified objectives.

Adaptive Management Liaisons - Delta Science Program staff members with expertise in the science supporting adaptive management. Their role is to provide advice on availability of models, regional monitoring, relevant research, and integrating individual adaptive management projects, plans, and programs across the Delta system. These staff members serve as liaisons to their counterparts in agencies and organizations that are planning and implementing adaptive management programs and projects including Delta Plan covered actions.

Best available science – Information and data generated through the application of a transparent and repeatable scientific process for informing management and policy decisions at a given point in time.[38] Best available science shall be consistent with the guidelines and criteria found in Appendix 1A of the Delta Plan.

Biological Opinion - A document stating the opinion of the U.S. Fish and Wildlife Service or the National Marine Fisheries Service as to whether or not federal action is likely to jeopardize the continued existence of a threatened or endangered species, or result in the destruction or adverse modification of critical habitat.

CASCaDE project - Computational Assessments of Scenarios of Change for the Delta Ecosystem is a research project to develop and apply a model-based approach of ecological forecasting to project future states of the Delta ecosystem, and to communicate the outcomes to resource managers. The objectives of this project are to develop and verify a set of models of climate, watershed hydrology, sediments, and water quality, and link these models to forecast how the Delta ecosystem will change.

Climate change - Any significant change in measures of climate (such as temperature, precipitation, or wind) lasting for an extended period (decades or longer). Climate change may result from (1) natural factors, including changes in the sun's intensity or changes in the Earth's orbit around the sun, (2) natural processes within the climate system (such as changes in ocean circulation), or (3) human activities that change the composition of the atmosphere (for example, through burning fossil fuels) and land surfaces (for example, deforestation, reforestation, urbanization, and desertification).

Collaboration - Sharing information and resources and modifying activities based on a common interest or objective that parties involved jointly define.[39]

[38] D.L Wright et al., "Trans-Disciplinary Collaboration to Enhance Coastal Resilience: Envisioning a National Community Modeling Initiative" (Washington DC, 2016), http://scholarworks.uno.edu/resilience.

[39] Delta Stewardship Council, 2016

Collaborative modeling - The modeling community comes together to jointly identify issues and work towards developing tools to address these issues using an iterative process that involves effective communication at all levels[40]

Coequal goals - The two goals of providing a more reliable water supply for California and protecting, restoring, and enhancing the Delta ecosystem. The coequal goals shall be achieved in a manner that protects and enhances the unique cultural, recreational, natural resource, and agricultural values of the Delta as an evolving place.[41]

Conceptual model - An explicit description of theoretical linkages, knowledge, and hypotheses about the structure and function of a system or process.

Cooperation - Sharing information and sometimes resources while each party pursues its own goals.[42]

Coordination -Sharing information and resources with parties pursuing a common interest or objective. The interest or objective, however, is defined independently by each party.

Credibility - Technical trustworthiness of the process and product.

CSAMP/CAMT - The Collaborative Science and Adaptive Management Program and Collaborative Adaptive Management Team are groups formed to coordinate adaptive management pursuant to the remand of the National Marine Fisheries Service and United States Fish and Wildlife biological opinions for listed fish species in the Delta. Both groups comprise agency and stakeholder representatives.

CWEMF - The California Water and Environmental Modeling Forum is a non-profit, non-partisan organization whose mission is to increase the usefulness of models for analyzing California's water-related problems.

Data - Recorded symbols (e.g., words, numbers, and images) and sensory readings that capture a set of facts about an event.[43] Examples include measures of precipitation, flow, and population abundance.

Delta - The Sacramento-San Joaquin Delta as defined in CA Water Code section 12220 and the Suisun Marsh, as defined in CA Public Resources Code section 29101.

Decision-maker - Includes both managers and agency directors and can also include stakeholders. Managers include individuals responsible for overseeing day-to-day functions (e.g. operations), implementing programs, research, policies, strategic planning, coordination and communication of the organization. Examples include participants of the Collaborative Adaptive Management Team, Interagency Ecological Program Science Management Team, and Delta Regional Monitoring Program Steering Committee. Directors are individuals who oversee agencies and large divisions (e.g. United State Geological Survey Bay-Delta region). Examples include members of the Collaborative Science and Adaptive Management Program, Delta Plan Interagency Implementation Committee and Interagency Ecological Program Director's Team participants.

Delta Plan - The comprehensive, long-term management plan for the Delta to further the achievement of the coequal goals, as adopted by the Delta Stewardship Council in accordance with the Sacramento-San Joaquin Delta Reform Act of 2009.

[40] Wright et al., 2016
[41] California Water Code section 85054
[42] DSC, 2016
[43] Liew, 2007

Delta science community - The group of scientists, including federal, State, and local agencies; academics, consultants, NGOs, and interested public who are actively participating in scientific and management activities in the Delta.

Ecosystem - A biotic community and its physical environment, considered as an integrated unit. Implied within this definition is the concept of a structural and functional whole unified through life processes. An ecosystem may be characterized as a viable unit of community and interactive habitat. Ecosystems are hierarchical and can be viewed as nested sets of open systems in which physical, chemical, and biological processes form interactive subsystems. Some ecosystems are microscopic, and the largest comprises the biosphere. Ecosystem restoration can be directed at different-sized ecosystems within the nested set, and many encompass multiple states, more localized watersheds, or a smaller complex of aquatic habitats.

Ecosystem restoration - The application of ecological principles to restore a degraded or fragmented ecosystem and return it to a condition in which its biological and structural components achieve a close approximation of its natural potential, taking into consideration the physical changes that have occurred in the past and the future impact of climate change and sea-level rise (Water Code section 85066).

Estuary - A place where fresh and salt water mix, such as a bay, salt marsh, or where a river enters an ocean.

Federated platform - A centralized system that gathers multiple data repositories, where the source databases remain unmodified.

Forum - A place, meeting, or medium (e.g. newspaper, website) where discussions take place on a particular issue.

Habitat restoration - The manipulation of the physical, chemical, or biological characteristics of a site with the goal of returning the majority of natural functions to the lost or degraded native habitat.

Horizon scanning - A process to identify emerging trends, issues, and opportunities that mangers and scientists should be aware of so they are better prepared to take advantage of or to react to in a well thought out and timely manner[44].

Independent scientific review - Assessment of a scientific or management product or program by scientists with appropriate expertise and no personal or institutional stake in the outcome of the review.

Information - A message with relevant meaning used to make decisions, solve problems, or realize an opportunity. Information can come from processed data but can also come from other forms of communication (e.g. instructions).[45]

Integrated modeling – Taking models that provide information on different parameters (e.g. hydrodynamics, fish movement, crop yield) and different sources of data and tying them together to provide a more holistic understanding of the system.

Interoperability standards - Standards that allow systems, devices and models to exchange data, interpret this shared data and ultimately be useful to users.

Introduced species – A non-native species that has been accidentally or deliberately transported to the new location by human activity.[46]

[44] N.R Haddaway et al. 2017
[45] Liew, 2007
[46] Science Daily, 2018

Legitimacy - The scientific process is being applied impartially and without partisan bias or prejudice.

Local agency – Any public agency other than a State or federal agency, board, or commission. A local agency may include, but is not limited to, cities, counties, districts, and public water agencies, and boards, commissions, or organizational subdivisions of a local agency.

Machine learning - A method to teach computers to identify patterns from data and make decisions rather than relying on a predetermined equation. The decision performance (such as predictive ability) improves as the amount of data fed into the computer increases and expands the pool to "learn" from.[47]

Manager - Includes both "science manager" and "natural resource manager". Upper level staff within an agency division responsible for overseeing day-to-day functions (e.g. operations), strategic planning, coordination and communication of the organization. Science managers may have expertise in a technical field and may partake in data analysis, monitoring design efforts, and authoring scientific publications.

Mechanism - A way of getting something done.

Model - An abstract simplification of the real world that formalizes hypotheses and current scientific understanding about how the modeled system works.

Monitoring - Ongoing sampling, analysis, measurement, and survey activities used by scientists and managers to assess status and trends of natural resources in the Delta system.

Open source - Any software, project, products, that people can inspect, modify, enhance, and share because its design is publically accessible.[48]

Peer review - The scientific process of subjecting research proposals or products, or management programs, to assessment by independent scientific experts.

Performance measures - A quantitative or qualitative tool to assess progress toward an outcome or goal.

Policymaker - Individuals who develop policies for their agencies and departments and also those who participate at the legislative level who develop state-wide and nation-wide regulations.

Policy-Science Forum - A forum where decision-makers, scientists, and stakeholders come together to facilitate learning to promote discussion of key issues and coalesce around a unified idea of high priority needs and questions, maintain connections throughout the development of a management decision, research project, modeling effort, or synthesis process, and build relationships among members of the Delta science community.

Process - A series of steps taken to get a result/achieve a goal.

Relevance - Close alignment of research to management information needs

Science - The use of evidence to construct testable explanations and predictions of natural phenomena, as well as the knowledge generated through this process.[49] Science can be (a) experimental where natural phenomena are described by observations, (b) theoretical where models or generalizations are formed, (c) computational where complex theoretical formulations are resolved and (d) data explorative (or e-Science) where theory, experiment

[47] MathWorks, 2018
[48] Opensource.com, 2018
[49] National Academy of Sciences, 2008

and simulation are unified. New knowledge is also discovered through data mining, visualization of complex processes and other emerging computational methodologies.[50]

Science Action Agenda - A document produced by the Delta Science Program in cooperation with the science community that prioritizes near-term actions to inform management actions and achieve the objectives of the Delta Science Plan.

Science activities - a broad range of efforts including compliance monitoring, modeling, exercises to identify science issues that may be of management concern in the near future, research focused on supporting decision-making, as well as more basic research that can support future management issues.

Science co-production - Participation of managers or stakeholders in the design, execution, and interpretation of scientific studies.[51]

Science enterprise - The collection of science programs and activities that exist to serve managers and stakeholders in a regional system.

Science governance – a form of collaborative governance that involves collectively prioritizing research questions, setting goals for science efforts, determine best practices for how science is conducted and results of these efforts(Sutherland and Woodroof 2009)[52].

Science infrastructure - The equipment, tools, resources, and systems that support the production, facilitation, organization, and communication of scientific knowledge. These include laboratories, offices, monitoring equipment, expert staff, computer and monitoring networks to transfer and share information, modeling networks that allow better multidisciplinary analysis, datasets, repositories, libraries, synthesis efforts, and web pages.

Science work plans - The set of near-term research activities and priorities carried out by the Delta Science Program in consultation and collaboration with an agency or other entity.

State of Bay-Delta Science - A summary and synthesis of the current state of scientific knowledge for the Delta, focused on the grand challenges of policymakers. The State of Bay-Delta Science was first published in 2008 by the CALFED Science Program. It is targeted to be updated by the Delta Science Program every four years.

Stakeholder - Anyone or any entity who has an interest in, can influence, or will be affected by the issue, set of findings, or action.[53]

Synthesis - The combining of often diverse information from multiple sources into one concept, model, finding, or report.

Tool - Something used to perform a job or task (e.g., computer, guidebook, checklist, boat).

Use case - Descriptions of how the information will be used, for what purpose, and the desired interactions between the user and the output interface (e.g. website, dashboard, interactive map, etc.).

Watershed - The land area that drains into a stream, river, lake, or sea at a given point. The watershed for a major river may encompass a number of smaller watersheds.

[50] Hey, Tansley, Tolle, & Tolle, 2009
[51] Beier et al., 2017; Lemos & Morehouse, 2005
[52] Lebel et al., 2005; Raik & Decker, 2007

[53] Haddaway et al., 2017

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APPENDIX A. SCIENCE GOVERNANCE AND THE COLLABORATIVE DELTA SCIENCE-SCAPE

Introduction

This appendix provides a more extended discussion and analysis of the network diagram displayed in Chapter 1. The analysis focuses on the existing structure of the collaborative Delta science-scape and serves as a starting point for visualizing and understanding the complexity inherent in the endeavor of collaboratively governing the science of a complex social-ecological system. Future analyses will investigate the nature of these relationships and the processes contributing to decisions across collaborative organizations. These include identifying levels of engagement and commitment, scope of responsibility of each venue, and need for resources (see section below on future investigations). The goal for these analyses is to serve as a tool to improve collaborative science governance in the Delta.

Collaborative science governance

Governance refers to the interactions among structures, processes, rules, and traditions that determine how people in societies make decisions and share power, exercise responsibility, ensure accountability, and give stakeholders a say in the management process (Sutherland & Woodroof, 2009). The interactions among structures, rules, and traditions provides the social context that allows collective action, rule-making, and institutions for social coordination (Dietz et al. 2003). In a complex social-ecological system like the Delta, governance is not about one individual or organization making a decision but rather multiple individuals within organizations and systems of linked organizations making decisions to advance the collective good.

Collaborative science governance is a form of governance that involves engaging people constructively across the boundaries of public agencies, levels of government and/or the public, private and civic spheres in order to collectively prioritize research questions, determine how science is conducted, and review and distribute the results. Collaborative science governance covers a range of science activities including how funding is directed to research programs aimed at achieving high priority science goals, best practices for carrying out research are established and communicated, and the results of science undergo review and are distributed to decision-makers and other users. The network analysis described here focus on the organizations involved in collaborative science governance as a first step.

Collaborative Delta science venues

The collaborative Delta science-scape is comprised of the formal, collaborative elements of the Delta science enterprise. This Appendix maps out the network of connections between the 12 main collaborative Delta science venues that contribute to science governance via the wide range of organizations participating in those venues. Taken together, the venues coordinate across a diverse range of actors working on the full set of science activities and study topics in the Delta. It is important to note that this network does not capture the full range of collaborative science efforts in the Delta; only those which are organized as formal, ongoing, multi-party venues are represented. Table A-1 provides the list of 12 collaborative venues including a description of their roles and the primary participants within each venue.

Who participates?

The set of organizations participating in collaborative Delta science venues include actors from multiple levels of government as well as non-governmental organizations, public research institutions, and private consultants. The primary actors are state and federal agencies with responsibilities related to water supply, water quality, wildlife management and habitat restoration. See Table A-2 for more information on the role these organizations play.

The six main federal agencies that participate in collaborative science governance in the Delta include the National Oceanic and Atmospheric Administration's National Marine Fisheries Service, the U.S. Army Corps of Engineers, the U.S. Bureau of Reclamation, the U.S. Environmental Protection Agency, the U.S. Fish and Wildlife Service, and the U.S. Geological Survey. There are multiple state agencies responsible for managing water resources and/or wildlife and habitat restoration. These include, but are not limited to, the Department of Fish and Wildlife, the Department of Water Resources, and the State Water Resources Control Board.

A number of city and county general government actors appear in the Delta collaborative science-scape, while the private sector is involved peripherally. Water special districts are governmental entities usually associated with a local government jurisdiction and perform at least one of four specific duties: water delivery (e.g. public water agencies), waste disposal/sanitation (e.g. publically owned treatment works), flood management, and water conservation. Water districts participate in the network individually or through larger member associations such as the Metropolitan Water District of Southern California (Metropolitan) or the State and Federal Contractors Water Agency (SFCWA[54]).

[54] Although SFCWA no longer exists, the organization has been a major player in the Delta science-scape and will be included in this set of analyses.

Table A-1. Collaborative science and policy organizations in the Delta

Acronym	Full name	Role/Purpose	Primary participants
CSAMP/ CAMT	Collaborative Science and Adaptive Management Program/Collaborative Adaptive Management Team	Collaboratively produce information and evaluate science and management actions associated with protection of species of concern and actions related to the State Water Project and Central Valley Project to improve performance of ecological systems and water supply.	State and federal entities and stakeholders involved in the court ordered remand schedule for completing revisions to Delta Smelt and salmonid and Biological Opinions (2008 and 2009 BiOps)
CWEMF	California Water and Environmental Modeling Forum	Increase usefulness of models for analyzing California's water related problems, facilitate exchange of information, resolve technical disagreements, ensure technical work takes into account stakeholder and management needs. Also non-partisan clearing house for models and peer review.	State and federal entities, entities with interests in water, universities, environmental org, private consultants, and general public (over 100 individual member entities).
CWQMC	California Water Quality Monitoring Council	Develop specific recommendations to improve the coordination and cost-effectiveness of water quality and ecosystem monitoring and assessment, enhance the integration of monitoring data across departments and agencies, and increase public accessibility to monitoring data and assessment information.	State and federal entities, citizen monitoring groups, the public, scientific community, agriculture, regulated water community and water supply community.
DPIIC	Delta Plan Interagency Implementation Committee	Bring together directors of agencies associated with the Delta Plan to coordinate their agency efforts to support goals of the Delta Plan.	17 State and federal entities involved in Delta Plan implementation.
DIISC	Delta Inter-agency Invasive Species Coordination Team	Foster communication and collaboration among California state agencies that detect, prevent, and manage invasive species and restore invaded habitats in the Sacramento-San Joaquin Delta	Federal, state, local , academic and other stakeholders
DRMP	Delta Regional Monitoring Program	Produce objective, cost-effective scientific information gathered in a streamlined way that provides a comprehensive understanding of	Central Valley Regional Water Quality Control Board, publically owned treatment works, storm water programs, irrigated agriculture, water suppliers, natural

Table A-1. Collaborative science and policy organizations in the Delta

Acronym	Full name	Role/Purpose	Primary participants
		water quality conditions and trends in the Delta.	resource and science managers, agency scientists.
IAMIT	Inter-agency Adaptive Management Implementation Team	Work in support of an integrated Adaptive Management Program for habitat restoration in the Yolo Bypass, Delta, and Suisun Marsh	Federal, state and local agencies involved in implementation or regulatory oversight of EcoRestore projects
IEP	Interagency Ecological Program	Collaboratively monitor, research, model, and synthesize information for adaptive management, water project operations, planning, and regulatory purposes relative to endangered fish and the aquatic ecosystem in the Bay-Delta.	State and federal agencies and departments.
IICG	Interagency Implementation and Coordination Group	Coordinate and implement the Adaptive Management Program for the California WaterFix.	Representative from each of the five state and federal agencies involved in California WaterFix
Nutrient STAG	Nutrient Stakeholder and Technical Advisory Team	Responsible for providing productive input representing the range of different interests involved in, and who may be affected by, the development and implementation of a Delta nutrient management strategy	State, federal and local agencies involved in water resources management (supply, quality, stormwater, irrigation etc.), NGOs and industry stakeholders
SWAMP	Surface Water Ambient Monitoring Program	Coordinates all water quality monitoring conducted by the State and Regional Water Boards	University and State and Federal agency experts in chemistry, toxicology, ecology, and hydrology
WOMT	Water Operations Management Team	Considers recommendations of technical teams, water supply costs, and other factors, provides guidance to DWR and USBR.	State and federal agencies associated with the Central Valley and State Water Projects

Table A-2. State and Federal Government Organizations

Name	Acronym	Focus topics	Role
	Federal		
National Aeronautics and Space Administration	NASA	water quality	research
National Marine Fisheries Service	NMFS	wildlife	regulatory
US Army Corps of Engineers	USACE	water supply	infrastructure construction
US Bureau of Reclamation	Reclamation	water supply	infrastructure operation
US Department of Agriculture	USDA	agriculture	regulatory
US Department of Interior	USDOI	water quality, wildlife	
US Environmental Protection Agency	USEPA	water quality	regulatory
US Fish and Wildlife	USFWS	restoration, wildlife	regulatory
US Geological Society	USGS	monitoring, water quality	research
	State		
California Department of Food and Agriculture	CDFA	agriculture	research
California Environmental Protection Agency	CalEPA	water quality	regulatory
California Natural Resources Agency	Resources	restoration, water quality, water supply, wildlife	regulatory
California State Parks and Recreation	State Parks	boating, recreation	regulatory
Central Valley Flood Protection Board	Flood Board	flooding, safety	regulatory
Central Valley Regional Water Qual. Control Board	CVRWQCB	water quality	regulatory
Delta Protection Commission	DPC	land use, natural resources	regulatory
Delta Science Program	DSP	science coordination	advisory
Delta Stewardship Council	DSC	restoration, water supply	regulatory
Department of Fish and Wildlife	DFW	wildlife	regulatory
Department of Water Resources	DWR	flooding, restoration, water supply	regulatory
Office of Environmental Health Hazard Assessment	OEHHA	water quality	regulatory
Sacramento-San Joaquin Delta Conservancy	Delta Conservancy	restoration	advisory
Southern California Coastal Water Research Project	SCCWRP	water quality	research
State Water Resources Control Board	SWRCB	flooding, water quality, water rights	regulatory

Science-scape network diagrams and summary of relationships

Understanding the composition of the venues with respect to other venues is important to determine who the key players are and where in the science-scape organizations can be expected to have a role in science communication and decision-making. This section provides a more detailed description of various collaborative venue compositions. Again, this analysis does not take into account the nature of these relationships (e.g. whether one organization informs another, any hierarchical relationships).

The Delta science-scape network is composed of two types of entities (or nodes*)*:

1) *Venues*: the collaborative science venues where multiple organizations engage in science governance, that is, organizations coordinate activities, develop research goals and select the means to meet those goals, and/or synthesize, review and communicate the results.

2) *Organizations*: the collection of government and stakeholder organizations participating in these venues, classified by type of organization.

The network models below (Figures A-1 and A-2) were formed by compiling a list of the 12 major collaborative Delta science venues (see Table A-1) and the list of participant organizations for each venue[55].

Figure A-1 is a visualization of the Full Network, which includes the collaborative venues and all of the organizations that participate in at least one of these venues. This is the "big picture" network and shows the full range of participants in collaborative Delta science. There are 94 organizations that participate in the Full Network.

Figure A-2 shows the collaborative science Core Network. This network was formed by removing organizations that participate in only one collaborative venue with the assumption that they are more peripherally involved. The resulting Core Network of 33 organizations affords a more focused examination of the set of organizations embedded in the collaborative Delta science system. It also provides a basis of comparison that reveals which venues coordinate heavily involved actors versus those that provide a point of engagement for the broader collaborative Delta science community.

One measure of influence in a network is known as *degree centrality*, which is defined as the number of links that connect a given node to other nodes in the network. Thus the more venues a given organization participates in, the more centrally it is located in the network. Similarly, the more organizations participate in a given venue, the more central that venue is. Due to their participation in a relatively large number of collaborative venues, there are a number of federal (green) and state (dark blue) agencies in the center of the diagram.

Table A-4 provides the number of organizations participating in the Full Network and Core Network, and the average number of venues in which each type of organization participates. Six of the nine federal agencies in the network participate in more than one venue and federal agencies on average participate in more venues (4.9) in the Full Network than any other organization type. State agencies comprise the next most central sector. Most of the state agencies (11 out of 15) attend more than one venue and on average participate in 3.9 venues. Many venues share the same organizational participants. These venues are not necessarily redundant, as they differ in scope and role. Identifying common participants between venues may provide insights such as how information is shared and commutated among different groups.

By contrast, only 2 of the 13 general local government agencies participate in more than one collaborative venue. Water special districts have the most representation in the full network with 19 organizations, but only eight of

[55] The list of participants were collected from official venue websites and thus may not fully capture all those who are affiliated with these venues. The participant list is currently undergoing review by members of the Delta science community to receive input on additional participants.

these participate in more than one venue. Identifying venues with large number or organizations that only participate in that venue provides insight into the importance of some venues as they are the only places where select organizations participate. Removing these venues, therefore, may affect stakeholder dynamics and should be a consideration during any decisions regarding consolidation or removal of collaborative groups.

Future investigations

This initial analysis laid out the basic geography of the Delta science-scape. Future investigations are needed to answer questions about how the structure of the network could be altered to more effectively achieve "good governance" of the Delta Science enterprise and to better understand the specific niches and roles in generating, communicating, and using science, as well as flows of resources such as funding or information across the network. Another important area for further inquiry to build off of the current analysis involves assessing the effectiveness of the collaborative science governance network. While it can be difficult to measure network-level outcomes, one way of evaluating the science governance system involves eliciting the perceptions of individuals engaged in the system, and tracking these perceptions over time. This can be accomplished through quantitative surveys and qualitative interviews targeting key participants and venue leadership.

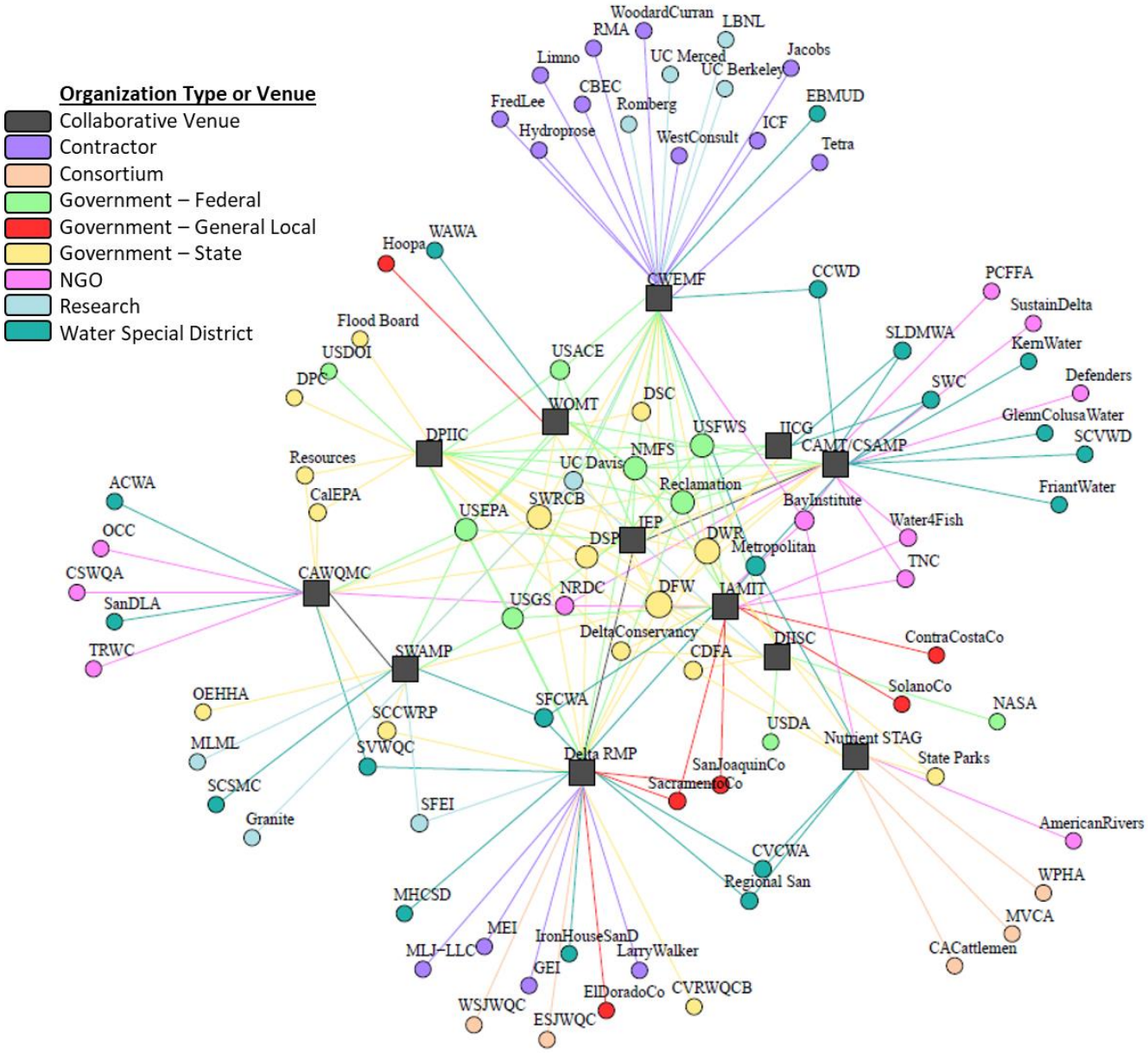

Figure A-1. The Delta science governance Full Network, showing the main 12 Delta science collaborative venues (black) and all of the organizations (colors) that participate in at least one such venue. Organizations are connected with ties (gray) to venues if they participate in that venue[56]. Both organizations and venues are more centrally located in the diagram the more ties they have. See Acronym list below for full name of venues.

[56] Note that in the case of CAMT/CSAMP, the participation structure is actually more simple, with multiple organizations represented by a single individual.

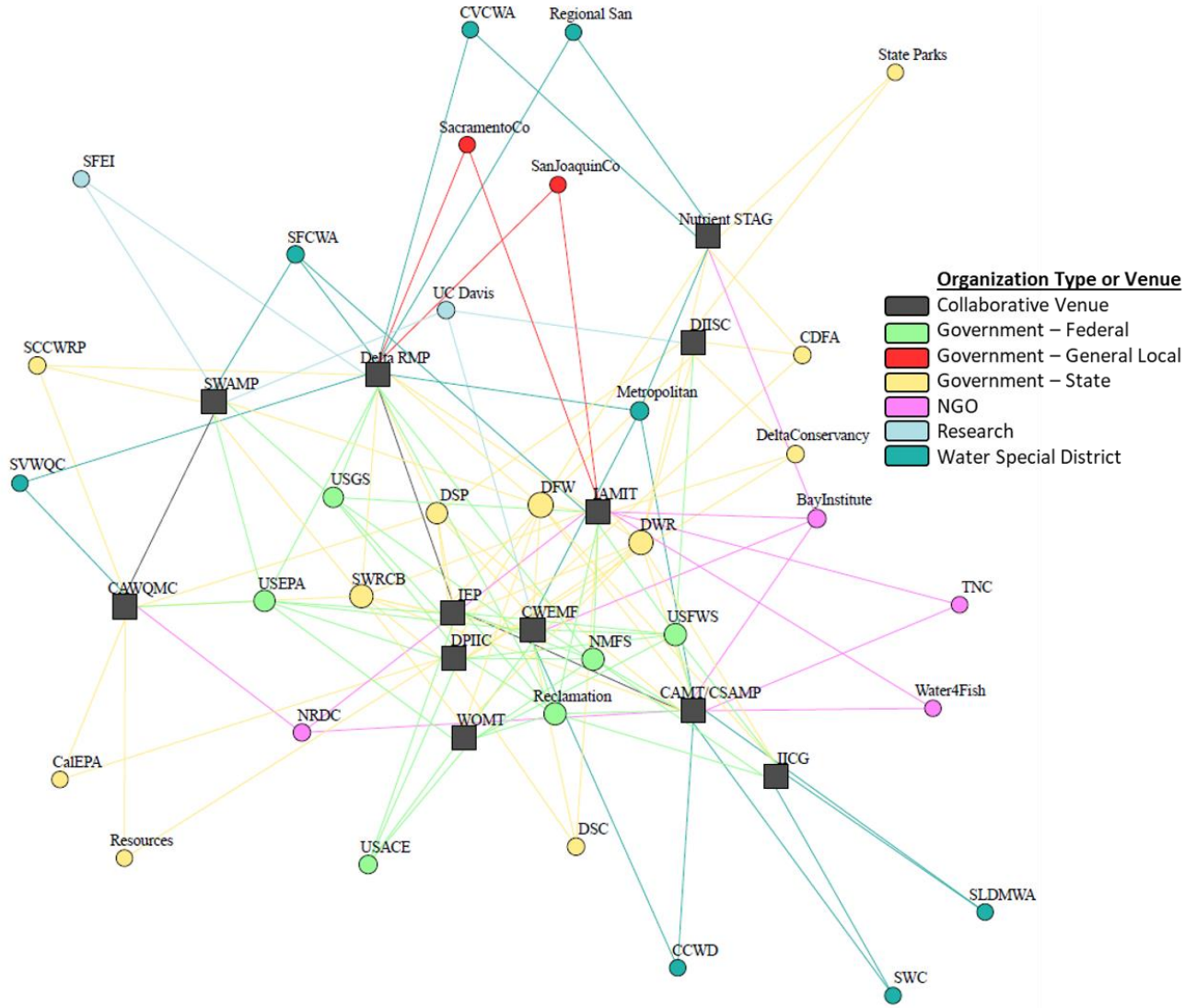

Figure A-2. The Delta science governance Core Network. This network diagrams shows each of the 12 main collaborative science venues and each organization that participates in more than one such venue. See Acronym list below for full name of venues.

Acronym list, Figures A-1, A-2

Acronym	Name	Acronym	Name
ACWA	Association of California Water Agencies	GlennColusaWater	Glenn-Colusa Irrigation District
AmericanRivers	American Rivers	Granite	Granite Canyon Marine Pollution Studies Lab
BayInstitute	The Bay Institute	Hoopa	Hoopa Valley Tribe
Brentwood	City of Brentwood	Hydroprose	Hydroprose Consulting
CACattlemen	California Cattlemen	IAMIT	Interagency Adaptive Management Integration Team
CalEPA	California Environmental Protection Agency	ICF	ICF Consulting
CAMT/CSAMP	Collaborative Adaptive Management Team	IEP	Interagency Ecological Program
CAWQMC	California Water Quality Monitoring Council	IICG	Interagency Implementation and Coordination Group
CBEC	CBEC Engineering	IronHouseSanD	Ironhouse Sanitary District
CCWD	Contra Costa Water District	Jacobs	Jacobs Engineering

Acronym	Name
CDFA	California Department of Food and Agriculture
CDWP	California Drinking Water Program
ContraCostaCo	County of Contra Costa
CSustDelta	Coalition for a Sustainable Delta
CSWQA	California Storm Water Quality Association
CVCWA	Central Valley Clean Water Association
CVRWQCB	Central Valley Regional Water Quality Control Board
CVWD	Coachella Valley Water District
CWEMF	California Water and Environmental Modeling Forum
Davis	City of Davis
Defenders	Defenders of Wildlife
Delta RMP	Delta Regional Monitoring Program
DeltaConservancy	Sacramento-San Joaquin Delta Conservancy
DFW	Department of Fish and Wildlife
DIISC	Delta Inter-agency Invasive Species Coordination Team
DPC	Delta Protection Comission
DPIIC	Delta Plan Interagency Implementation Committee
DSC	Delta Stewardship Council
DSP	Delta Science Program
DWR	Department of Water Resources
EBMUD	East Bay Municipal Utility District
ElDoradoCo	County of El Dorado
ESJWQC	East San Joaquin River Watershed Coalition
Flood Board	Central Valley Flood Protection Board
FredLee	G. Fred Lee and Associates
FriantWater	Friant Water Authority
GCID	Glenn-Colusa Irrigation District
GEI	GEI Consultants
GGSA	Golden Gate Salmonid Association
GlennColusaWater	Glenn-Colusa Irrigation District
Granite	Granite Canyon Marine Pollution Studies Lab
Hoopa	Hoopa Valley Tribe
Hydroprose	Hydroprose Consulting
IAMIT	Interagency Adaptive Management Integration Team
ICF	ICF Consulting
State Parks	California State Parks and Recreation
Stockton	City of Stockton
SustainDelta	Coalition for a Sustainable Delta
SVWQC	Sacramento Valley Water Quality Coalition
SWAMP	Surface Water Ambient Monitoring Program
SWC	State Water Contractors
SWPCA	State Water Project Contractors Authority
SWRCB	State Water Resources Control Board
Tetra	Tetra Tech
TNC	The Nature Conservancy
Tracy	City of Tracy
TRWC	Truckee River Watershed Council
UC Berkeley	UC Berkeley
UC Davis	University of California, Davis

Acronym	Name
KCWA	Kern County Water Agency
KernWater	West Kern Water District
LarryWalker	Larry Walker Associates
LBNL	Lawrence-Berkeley National Labs
Limno	LimnoTech
MEI	McCord Environmental, Inc.
Metropolitan	Metropolitan Water District
MHCSD	Mountain House Community Services District
MLJ-LLC	Michael L. Johnson, LLC
MLML	Moss Landing Marine Laboratories
MVCA	Mosquito and Vector Control Associations
NASA	National Aeronautics and Space Administration
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NRDC	Natural Resource Defense Council
Nutrient STAG	Nutrient Stakeholder Technical Advisory Group
OCC	Orange County Coastkeeper
OEHHA	Office of Environmental Health Hazard Assessment
PCFFA	Pacific Coast Federation of Fisherman's Associations
Reclamation	US Bureau of Reclamation
Regional San	Sacramento Regional County Sanitation District
Resources	California Natural Resources Agency
RMA	RMA Companies
Romberg	Romberg Tiburon Center for Environmental Studies
Sacramento	City of Sacramento
SacramentoCo	County of Sacramento
SanDLA	Sanitary Districts of LA
SanJoaquinCo	County of San Joaquin
SCCWRP	Southern California Coastal Water Research Project
SCSMC	Southern California Stormwater Monitoring Coalition
SCVWD	Santa Clara Valley Water District
SFCWA	State and Federal Contractors Water Agency
SFEI	San Francisco Estuary Institute
SLDMWA	San Luis and Delta Mendota Water Authority
SolanoCo	County of Solano
USDA	US Department of Agriculture
USDOI	US Department of Interior
USEPA	US Environmental Protection Agency
USFWS	US Fish and Wildlife
USGS	US Geological Society
Vacaville	City of Vacaville
Water4Fish	Water4Fish
Watershed	The Watershed Project
WAWA	Western Area Water Administration
WestConsult	West Consultants, Inc.
Westlands	Westlands Water District
WOMT	Water Operations Management Team
WoodardCurran	Woodard & Curran
WPHA	Western Plant Health Association

Acronym	Name	Acronym	Name
UC Merced	UC Merced	WSJWQC	Westside San Joaquin River Watershed Coalition
USACE	US Army Corps of Engineers	YoloCo	County of Yolo
		Yurok	Yurok Tribe

Table A-4. Participation by Organization Type

Type	Number of participants	Mean number of venues
	Full Network	
Government - Federal	9	4.9
Government - Local General	13	1.2
Government - State	15	3.9
NGO	11	1.6
Research	8	1.4
Water Special Districts	19	1.6
Consortium	14	1.0
Consultant	5	1.0
	Core Network	
Government - Federal	6	6.8
Government - Local General	2	2.0
Government - State	11	5.0
NGO	4	2.8
Research	2	2.5
Water Special Districts	8	2.4
Consortium	0	0.0
Consultant	0	0.0

Table A-6. Participation by Venue

Venue	Acronym	Number of participants	
		Full	***Core***
Delta Regional Monitoring Program	Delta RMP	33	18
California Water and Environmental Modeling Forum	CWEMF	30	16
Collaborative Adaptive Management Team	CAMT/CSAMP	23	16
Interagency Adaptive Management Integration Team	IAMIT	19	15
Delta Plan Interagency Implementation Committee	DPIIC	18	15
California Water Quality Monitoring Council	CAWQMC	14	12
Nutrient Stakeholder Technical Advisory Group	Nutrient STAG	13	9
Surface Water Ambient Monitoring Program	SWAMP	13	9
Interagency Ecological Program	IEP	12	8
Water Operations Management Team	WOMT	10	8
Delta Inter-agency Invasive Species Coordination Team	DIISC	10	8
Interagency Implementation and Coordination Group	IICG	7	7

APPENDIX B. STATUS OF ORIGINAL ACTIONS IN 2013 DELTA SCIENCE PLAN AND RELEVANT PRODUCTS

Footnotes are provided if substantial changes have been made to an action in this current document (e.g. merged with another action, put in another chapter).
(*) indicate the action has been removed from this current Delta Science Plan.

ACTION NUMBER	SHORT TITLE	ACTION STATUS	EXAMPLE RELATED PRODUCTS
CHAPTER 2: ORGANIZING SCIENCE TO INFORM POLICY AND MANAGEMENT			
2.1	Establish a Policy-Science Forum	Ongoing[57]	Delta nutrient research plan, Delta RMP, CAMT Salmon Scoping Team report, CAMT outflow work plan, CAMT/NOAA salmonid Workshop
2.2	Develop, implement, and update a Science Action Agenda	Ongoing	2017-2021 Science Action Agenda, 2015 High-Impact Science Actions Interim Science Action Agenda
2.3	Sustain a web-based tracking system of science activities[58]	Initiated[59]	
2.4	Establish a Science Advisory Committee*	Completed	Delta Science Program Science Advisory Committee
2.5	Enable and identify resources for focused science synthesis[60]	Ongoing	
2.6	Publish and update the State of Bay-Delta Science	Ongoing	2016 *State of Bay Delta Science*
2.7	Deliver annual state-of-Delta science address*	No longer relevant[61]	
2.8	Develop and report performance measures[62]	Early development[63]	
CHAPTER 3: ADAPTIVE MANAGEMENT FOR A COMPLEX SYSTEM			
3.1	Provide Adaptive Management Liaisons	Habitat restoration – ongoing Water supply – not initiated	

[57] Ongoing: Effort is funded and currently underway
[58] Moved to joint implementation chapter in current document (chapter 5, action 5.2.2)
[59] Initiated: Effort is funded and in early stages of implementation
[60] Language modified and moved to science infrastructure chapter in current document (chapter 3, action 3.6.3)
[61] No longer relevant: The way the action is phrased is no longer relevant to the overarching goals of the Delta Science Plan. The action will have been either removed or combined with another action.
[62] Moved to joint implementation chapter (chapter 5, action 5.2.1)
[63] Early development: In conceptual stages (e.g. Scope of work drafted, request for proposals process started)

ACTION NUMBER	SHORT TITLE	ACTION STATUS	EXAMPLE RELATED PRODUCTS
3.2	Develop and use adaptive management frameworks	Habitat restoration – ongoing Water supply –Initiated	IAMIT white paper, water supply reliability AM framework (under development)
3.3	Model future scenarios[64]	Ongoing	Many focused studies (e.g. effects of Waterfix)
3.4	Hold an annual Adaptive Management Forum	Initiated	
CHAPTER 4: BUILDING THE INFRASTRUCTURE FOR SCIENCE			
4.1	Support research	Ongoing	Prop 1 related research efforts, Operation Baseline-related studies, Delta Science Fellows
4.2.1	Support and sustain a web-based information system for monitoring activities[65]	No longer relevant-see footnote	
4.2.2	Build a comprehensive Delta monitoring strategy for an integrated program	Not initiated	
4.3.1	Host a data summit*	Completed	Data summit white paper, AB 1755 and related efforts
4.3.2	Develop guidelines for data sharing[66]	Ongoing	AB 1755 related efforts
4.4.1	Develop a collaborative community modeling framework	Ongoing	IMSC efforts
4.4.2	Develop, update, and maintain conceptual models*	Ongoing	IEP workgroup on tidal wetlands monitoring has conceptual models related to fish and food web
4.4.3	Support high-priority model development	Ongoing	UCD/Watermaster study comparing Delta consumptive use estimates
4.4.4	Embrace alternative modeling approaches*[67]	Ongoing	
4.5.1	Foster integrative synthetic thinking throughout the Delta science and management communities	Ongoing	FLaSH, SAIL, MAST, NCEAS-POD, tidal-wetland monitoring work group, other IEP workgroup efforts
4.5.2	Establish mechanisms and protocols for ongoing synthesis	Not initiated	
4.6.1	Seek broad support and use of a standard process for conducting scientific peer review	Ongoing	Waterfix aquatic science review, Delta RMP monitoring design review, Yolo Bypass habitat restoration and fish passage review, long-term operations Biological Opinions science review
4.6.2	Develop a response mechanism to scientific peer review*	No longer relevant	

[64] Incorporated into chapter 3 modeling language
[65] Modified and combined in infrastructure chapter (chapter 3, action 3.4.2)
[66] Modified to action 3.4.2

[67] Merged into language for inter-comparison and collaborative modeling (chapter 3 section 3.5)

ACTION NUMBER	SHORT TITLE	ACTION STATUS	EXAMPLE RELATED PRODUCTS
4.7.1	Develop and implement a communication strategy	Ongoing	
4.7.2	Develop and maintain new web-enabled content	Ongoing	Estuaries Portal, EcoAtlas, Bay Delta live, social media
CHAPTER 5: RESOURCES TO IMPLEMENT THE DELTA SCIENCE PLAN			
5.1	Develop a joint funding strategy for the Delta Science Plan	Not initiated	
5.2	Adequately staff the Delta Science Program*	No longer relevant	
5.3	Supplement the Delta Science Program with rotators*	No longer relevant	
5.4	Implement and sustain the science infrastructure*	Ongoing	

1 # List of Acronyms

AM: Adaptive Management
AB: Assembly Bill
CAMT: Collaborative Adaptive Managing Team
Delta RMP: Delta Regional Monitoring Program
FLaSH: Fall Low Salinity Habitat
IAMIT: Interagency Adaptive Management Implementation Team
IMSC: Integrated Modeling Steering Committee
MAST: Management Analysis and Synthesis Team
NCEAS: National Center for Ecological Analysis and Synthesis
NOAA: National Oceanic and Atmospheric Administration
POD: Pelagic Organism Decline
SAIL: Salmon and Sturgeon Assessment Indicators by Life stage
UCD: University of California, Davis

2

APPENDIX C: PROCESS FOR UPDATING THE SCIENCE ACTION AGENDA

Science Action Agenda

The Science Action Agenda identifies prioritized science activities to fill gaps in knowledge, achieve key objectives in the Delta Science Plan, and build science capacity to address decision-makers' challenges and management issues. The Science Action Agenda does not cover every important science activity in the Delta but focuses on those that serve as "gaps and glue"; science actions that are recognized as cross-agency and multi-group priorities and promote collaborative efforts, but fall between the mission statements and priorities of any single organization.

The first Science Action Agenda was released in September 2017 following interim efforts in 2014 and 2015. The Science Action Agenda will be updated every four years to reflect the ever-evolving Delta science landscape, although the process will retain flexibility to conduct science around unanticipated events (e.g., flood, earthquake, drought, levee failure, salt-water intrusion into the Delta). In these cases, the Delta Science Program will lead the effort to adjust the prioritized actions by working with the Delta science, management, and policy communities in an open and transparent manner. This update approach enables the Science Action Agenda to be nimble and responsive to new conditions without compromising the near-term investments necessary to yield desired long-term dividends.

Updating the Science Action Agenda

Major thematic areas and specific science actions in the Science Action Agenda will be updated and identified every four years through an open process led by the Delta Science Program. Input from the Delta science community, including federal and State agencies, local agencies, academics, and interested public, will be received through outreach efforts (e.g., forums and workshops), surveys, and directed interviews, while additional information will be sourced from web-based inventories of science activities and strategic documents developed by various collaborative science groups in the Delta. The Delta Agency Science Workgroup, science advisory groups, and the lead scientists from Delta Science Program and IEP will provide guidance on refining and prioritizing the updated list of science actions and overarching action areas through applying a set of screening and prioritization criteria. The screening and prioritization criteria can be found in Boxes C-1 and C-2. The Delta Lead Scientist is responsible for articulating the rationale for the updated actions.

The Science Action Agenda may be updated more regularly in response to major changes in the Delta (e.g., major flood or invasion of non-native species) that require science support.

The 2021 updated Science Action Agenda will include two additional sections:

HORIZON SCANNING

Horizon scanning involves using a systematic process of assessing emerging trends such as changes in ecological processes, updated scientific understanding, new technology, and socio-economic dynamics that may be on the margins of today's management focus, but may be important in the future. Future updates to the Science Action Agenda will include a horizon scanning exercise to determine these emerging trends and potential actions to take to support timely management decisions and reduce the likelihood of unwanted surprises in the future (Sutherland & Woodroof, 2009). Horizon scanning requires early input and interactions between experts from social, natural, and physical sciences and decision-makers to determine how to address upcoming issues that may be of importance to management decisions. Methods for assessing possible future issues may include focused interviews, literature searches, workshops, web mining, and surveys (Sutherland & Woodroof, 2009).

For the Science Action Agenda, horizon scanning topics should focus on:

a. Emerging science and technology identified in updates to the State of Bay Delta Science
b. Ecological and physical processes and trends (e.g. new water quality contaminants, introduced species, population dynamics, climate change induced patterns) having a high likelihood of becoming an important management issue in the near future
c. Other anticipated long-term science needs

TOP DELTA SCIENCE QUESTIONS OF HIGH MANAGEMENT RELEVANCE

Another element that will be included in the upcoming update of the Science Action Agenda will be a list of the top 50-100 science questions that have high management relevance. These will be in addition to the "gaps and glue" science actions. A potential method of identifying these additional science questions is to include the top 50-100 science actions that address key management needs selected through the application of both the screening and prioritization criteria used in developing the Science Action Agenda actions. These could be presented at policy-science forums for discussion between scientists and decision-makers regarding how appropriate the questions are in answering management needs.

REVIEW PROCESS

The Science Action Agenda will be reviewed by the public and Delta Independent Science Board, consistent with its responsibility to provide oversight of the scientific research, monitoring, and assessment programs that support adaptive management of the Delta.

Joint implementation of the Science Action Agenda

The Science Action Agenda will be the shared science priority actions for the Delta science enterprise. It will provide the overarching agenda and direction for developing and updating individual science programs' work plans. The Delta Science Program and Delta Plan Interagency Implementation Committee agency directors will coordinate the implementation of the Science Action Agenda through an open process that connects agencies and interested parties to collectively fund priority actions. Collective implementation of the Science Action Agenda will build the knowledge base and science tools necessary to address decision-makers' needs. New knowledge gained through implementation of the Science Action Agenda will inform updates to the State of Bay-Delta Science as well as the Science Action Agenda.

The final document will be presented to the Delta Stewardship Council for acceptance and the Delta Plan Interagency Implementation Committee for endorsement. Similar to implementation of the Delta Science Plan, joint implementation of the Science Action Agenda will involve coordination among the Delta Plan Interagency Implementation Committee's agencies and stakeholders to carry out the actions through solicitations, coordinating projects, and identifying where current resources can be leveraged.

Box C-1. Screening Criteria for Including Science Actions in the SAA

1. Science Topics/Actions Not Fully Addressed
    a. Forthcoming decisions requiring information to evaluate best alternative: are only partially supported – alternatives and their associated uncertainties have not been fully explored.
    b. Management need is only partially addressed by an agency, set of agencies, or groups and requires further attention from the Delta community.
    c. Science action is only being partially funded or addressed by an agency or group and requires cross-agency support or is currently not being addressed by any group. Science actions that are well supported or in the final stages of implementation do not fall under this criterion.

2. Cross-Agency and Multi-Group Priority
    a. Management need is relevant to multiple agencies and organizations throughout the Delta and/or fulfills the mission of multiple groups.
    b. Science action is not site specific or single agency focused and integrates the research and science goals of the larger Delta science community.
    c. The science action is linked to a high-priority policy issue that has cross-agency implications such as the California Water Action Plan, EcoRestore, WaterFix, the Delta Plan, or a new Governor's initiative.
    d. Executing the science action will help address achievement of the coequal goals in the Delta Plan.
    e. The outputs of the action will be directly used in water management or ecosystem management; the action has broad agency and stakeholder support.
    f. The action is included in multiple priority lists by science programs that carry out research and monitoring in the Delta.

3. Feasible
    a. The action can likely proceed given legal, fiscal, and institutional considerations.
    b. The capacity to carry out the research successfully is well established and described.

4. Promotes Collaborative Efforts
    a. Implementing the science action will provide opportunities to serve the needs of multiple agencies and organizations.
    b. The science action is synergistic with existing efforts and will support multi-agency collaboration.

Box C-2. Prioritization Criteria for Actions in the SAA

1. Scientific Merit
    a. The action is based on a sound rationale (e.g., has a high degree of support from relevant science communities and high potential to advance knowledge).
    b. Recommended by the Delta Lead Scientist, IEP Lead Scientist, Delta Independent Science Board, or an independent peer review panel.

2. High-Impact
    a. The action is useable by one or more key agencies within a four-year time frame.
    b. Identifies and addresses current or anticipated gaps in knowledge relevant to multiple agencies.
    c. Involves integrating existing data from individual agencies spanning various geographical locations.
    d. Identifies emerging issues requiring a rapid Delta-wide assessment to develop management needs.
    e. Supports synthesis activities that cross multiple existing programs or agency missions.
    f. Supports science infrastructure needs (the action supports the Delta science enterprise, and provides tools, facilities, or professional development for scientists).
    g. Has a high potential to address and resolve areas of scientific conflict.

3. Timeliness/ Need
    a. The action is ready for further development and the opportunity for progress is high.
    b. The project has partial support and commitments that can be greatly enriched by focused short-term attention.

4. Risk Assessment/ Opportunity Cost
    a. Not taking this action today would pose a severe risk to core scientific, technical, and organizational capabilities to address management needs today and in the future.
    b. Addressing this scientific topic is an immediate opportunity for innovation and scientific advancements with high potential for critical new knowledge of the Delta.

APPENDIX D. THE STATE OF BAY-DELTA SCIENCE

Objective

Regularly summarize and communicate the state of current scientific knowledge for the Delta to inform policy, management decisions, and associated challenges. This includes assessing progress made on key research questions and identification of knowledge gaps.

Content and use

The State of Bay-Delta Science is a collection of synthesis reports summarizing the latest scientific understanding of the Delta. Scientific information is distilled and presented in a manner that can be used to support policy and management decisions and inform future science endeavors. Future editions of the State of Bay-Delta Science will focus on drawing strong connections between management and policy needs to the science presented in all chapters and will be used to guide updates to the Science Action Agenda.

Production timeline

Two volumes of the State of Bay-Delta Science have been produced, the first in 2008 and the second in 2016. Following the release of the second volume in 2016, consideration was given to making the State of Bay-Delta Science a living document with a full summary report published at least once every four years. There would more frequent publication of topical synthesis reports and periodic online updates released as new knowledge becomes available. The four-year production cycle of the State of Bay-Delta Science will be aligned with the Biennial Bay-Delta Science Conference (offset from development of the Science Action Agenda). During production years, public gatherings of the Delta science community (e.g., the Biennial Bay-Delta Science Conference, Annual IEP Workshop, other synthetic workshops such as CABA, and State of the Estuary Conference) will be used to gather additional input on the topics addressed in the State of Bay-Delta Science.

Authors and publishers

The State of Bay-Delta Science will be written by relevant science experts with guidance from an editorial board. The Delta Science Program will be responsible for publishing the State of Bay-Delta Science.

Review process

Individual the State of Bay-Delta Science topical synthesis reports will be published in a peer-reviewed, open access journal (i.e., San Francisco Estuary and Watershed Science). The process by which the State of Bay-Delta Science is produced will be reviewed by the Delta Independent Science Board, after completion of the full summary report, at least once every four years.

APPENDIX E: POLICIES AND PROCEDURES FOR INDEPENDENT SCIENCE WORKSHOPS

Background

As part of its mission to provide the best available scientific information, to guide management and inform policy making in the Bay-Delta system, the Delta Science Program (DSP) promotes and provides independent synthesis of the state of scientific knowledge on topics of importance to decision-makers. The purpose of a workshop is to obtain a synthesis of the scientific information, on an important topic with major management or policy implications, based on published papers, reports, and other information—including professional judgment and experience, in a short period of time. The policies and procedures below describe how science workshops provided by the Delta Science Program will be conducted.

Decision to Hold a Workshop

A science workshop may be requested by an agency or other interested party. The workshop will focus on the scientific information related to an important topic with management or policy implications. The Delta Science Program's decision to conduct a workshop will depend on other, sometimes competing, commitments of the Delta Science Program and the relevance of the workshop of the goals and objectives to the Delta Stewardship Council. Moreover, the Delta Science Program will only agree to conduct a workshop if there is sufficient funding available, sufficient time available to complete the workshop and deliver a report, and sufficient scientific information to justify a workshop. The ultimate decision to conduct a workshop rests with the Lead Scientist for the Delta Science Program.

Planning Meetings

Meetings to plan for a workshop may be held with members of the requesting party and interested agency/stakeholder representatives (Workshop Planning Group) prior to initiation of the workshop. Participants in a Workshop Planning Group communicate their expectations for the pending workshop, provide input on the Charge to the Panel, consider the workshop agenda and panel-member composition, and provide pertinent background documents or other instructional scientific materials for the workshop through the Delta Science Program.

Charge to the Panel

Charge questions are developed with input from the Workshop Planning Group. The Lead Scientist has the final authority for the Charge to the Panel. Charge questions will be technical (or analytical) in nature, and will not include policy prescriptions (however, it is recognized that responses and other information in a workshop report may be used in future decision-making by resource managers and policymakers). Accordingly, charge questions will be crafted to best draw applicable guidance, but not to solicit explicit policy recommendations or prescriptions.

The scope of the Charge to the Panel will include background information (including the legal, regulatory, and management background necessary to set the full policy context for the Charge to the Panel), questions and tasks for the panel, a description of the role of the panel and rules for its deliberation, the form and scope of the workshop product, and a timeline of deliverables.

Independent Science Workshop Panel

Panels will include no fewer than three members. The Lead Scientist has the final authority for the selection of Independent Science Workshop Panel members and will consider input from the Workshop Planning Group. The

selection of panelists will consider an individual's standing in the scientific community, expertise in disciplinary areas, technical skills relevant to the documents, presentations, and technical issues to be evaluated in the workshop, and absence of a demonstrated conflict of interest. A panel, as a whole, is expected to have a broad range of expertise including some familiarity with the geographic region, physical processes, policy issues, ecosystems, and species-specific aspects of the workshop topic.

Workshop Materials

Materials to be provided to the Independent Science Workshop Panel will include scientific literature relevant to the workshop topic and pertinent background materials. Workshop materials may also include a preliminary synthesis report prepared by or under the direction of Delta Science Program staff. Background materials will not be limited to the specific technical questions and issues in the Charge to the Panel, but can include documents describing the legal and regulatory context of the workshop questions and tasks, and consider the management implications of materials provided to the workshop panel and relevant to the workshop report. Other study materials or information identified as pertinent to the workshop introduced by panel members during the panel meeting can be used at the discretion of the panel. Panels are encouraged to request any additional information or other materials that might facilitate their deliberations and report production. Stakeholders and other interested parties may submit materials to be considered by the workshop panel; however, final decisions relating to any materials provided to the panel rest with the Lead Scientist.

Workshop Presentations

In addition to the written materials provided to the panel prior to the workshop, scientific presentations will be conducted as part of the public component of the workshop. As with written materials, presentations may provide necessary background and regulatory context, but most presentations will focus on recent and ongoing scientific research, synthetic efforts by local experts, and scientifically-based expert opinion. Stakeholders and other interested parties may propose topics and presenters to address the panel; however, final decisions related to any presentations rest with the Lead Scientist.

Communication with the Panel

No direct communications by interested parties (including the agency or party that requested the workshop) with panel members on issues pertinent to the workshop should be made without the knowledge and consent of the Delta Science Program. The panel may be asked to disregard any communication received without the knowledge and consent of the Delta Science Program.

Public Meetings

The workshop process will be open and transparent to the extent possible. Unless there are compelling reasons to do otherwise, each independent scientific workshop will have a public meeting. The workshop panel will deliberate on camera to develop their recommendations and an opportunity for public comment will be provided as a part of any open (public) sessions of each workshop.

Public Communication

A webpage accessible through the Delta Stewardship Council and Delta Science Program website will present background information on each Independent Science Workshop, meeting agendas, membership of panels convened, all background materials and presentations, and the final panel document. To the extent possible, all materials for panel will be posted on the website at the same time that they are provided to the panel; at a minimum, 10 days in advance of the first public meeting of the workshop panel. Scheduling and other information about that meeting and the availability of workshop report(s) will be sent to the Delta Stewardship Council's listserv.

The Delta Science Program will compile and retain a record of the workshop, including the materials described above, as well as any additional materials provided to the panel including presentations from the public sessions of meetings.

Panel Report(s)

The Delta Science Program may suggest grammatical or formatting edits of a draft report to improve it, but will not otherwise substantively amend a workshop panel report. The content, substance, and recommendations of a workshop panel report are those of the panel, not the Delta Science Program or Delta Stewardship Council. The Delta Science Program will post the report after approval of the panel. The Delta Science Program may provide a courtesy copy of the report to the agency or party that requested the workshop in advance of posting the report. If the agency that requested the workshop chooses to develop a written response, the response will be posted along with the report at the time it becomes available.

APPENDIX F. POLICY AND PROCEDURESFOR INDEPENDENT SCIENTIFIC REVIEW

Background

As part of its mission to provide the best available scientific information to guide management and inform policy in the Bay-Delta system, the Delta Science Program promotes and provides independent scientific review of processes, programs, plans, and products. The policies and procedures below describe how independent scientific review provided by the Delta Science Program will be conducted.

Decision to provide review

Independent scientific review may be requested by any agency or other interested party. The review will focus on one or more written documents. The Delta Science Program's decision to provide a review will depend on other, sometimes competing, commitments of the Delta Science Program and the relevance of the review with respect to the goals and objectives of it and the Delta Stewardship Council. Moreover, the Delta Science Program will only agree to provide a review if there is sufficient funding available for the review, if there is sufficient time available to complete the review and deliver a report, and if the proposed materials are complete and ready for review. The ultimate decision to provide a review rests with the Delta Science Program's Lead Scientist.

Planning meetings

The review planning group typically meets several times prior to the review. Participants in the review planning meetings may include members of the requesting party, authors of the document(s) subject to review, and interested agency/stakeholder representatives, as determined by the Delta Science Program and the review-requesting party. Participants in a Review Planning Group composed of those parties, may communicate their expectations for the pending review, provide input on the Charge to the Panel, consider the review schedule and panel-member composition, and provide pertinent background documents or other instructional materials for the review through the Delta Science Program.

Charge to the panel

Charge questions are developed with input from the Review Planning Group. The Lead Scientist has the final authority for the Charge to the Panel. Charge questions will be technical (or analytical) in nature, and will not include policy prescriptions (however, it is recognized that responses and other information in a review report may be used in future decision-making by resource managers and policymakers). Accordingly, charge questions and tasks will be crafted to best draw applicable guidance, but not to solicit explicit policy recommendations or prescriptions.

The scope of the Charge to the Panel will include background information (including the legal, regulatory, and management background necessary to set the full policy context for the Charge to the Panel), questions and tasks for the panel, a description of the role of the panel and rules for its deliberations, the form and scope of the review product, and a schedule of deliverables.

Independent science review panel

Panels generally consist of no fewer than five members. Potential panel members may be identified through Delta Science Program staff input, the Delta Science Program's science expert database, publication records on relevant topics, and Lead Scientist and other professional recommendations (i.e., from other leading scientists and the planning committee). The Lead Scientist has the final authority for the selection of Independent Scientific Review Panel members and will consider input from the Review Planning Group. The selection of panelists will consider an

individual's standing in the scientific community, expertise in disciplinary areas, technical skills relevant to the documents and issues subject to review, and absence of a demonstrated conflict of interest. Collectively, a panel is expected to have a broad range of expertise including some familiarity with the geographic region, physical processes, policy issues, ecosystems, and species-specific aspects of the review.

Materials for review

Materials to be reviewed by the Independent Scientific Review Panel include the review document(s) and pertinent background materials. Background materials will not be limited to the (specific) technical questions and issues in the Charge to the Panel. Materials can include documents describing the legal and regulatory context of the review questions and tasks, providing the management implications of materials provided to the review panel, and any other documents relevant to the review report. Other study materials or information identified as pertinent to the review introduced, by panel members during the panel meeting, can be used at the discretion of the panel. Panels are encouraged to request any additional information or other materials that might facilitate their deliberations and report production. Stakeholders and other interested parties may submit materials to be considered by the review panel; however, final decisions relating to any materials to be provided to the review panel rest with the Lead Scientist.

Communication with the panel

No direct communications by interested parties, including the agency that produced the document subject to review, should be made with panel members on issues pertinent to the review during the review period without the knowledge and consent of the Delta Science Program. The panel may be asked to disregard any communication received without the knowledge and consent of the Delta Science Program.

Public meetings

The review process will be open and transparent to the extent possible. Unless there are compelling reasons to do otherwise, each independent scientific review will have a public meeting. While the review panel deliberates to develop their recommendations, the opportunity for public comment will be provided as a part of any open (public) sessions of each review.

Public communication

A webpage accessible through the Delta Stewardship Council and Delta Science Program website will present background information on each independent Scientific Review undertaken, meeting agendas, membership of panels convened, all background materials and documents to be reviewed, and the final review document. To the extent possible, all materials for panel review will be posted on the website at the same time that they are provided to the panel; at a minimum, 10 days in advance of the first meeting of the review panel. Scheduling and other information about that meeting and the availability of review report(s) will be sent to the Delta Stewardship Council's listserv.

The Delta Science Program will compile and retain a record of the review, including the materials described above as well as any additional materials provided to the panel including presentations from the public sessions of meetings.

Panel report(s)

The Delta Science Program may suggest grammatical or formatting edits of a draft report to improve it, but will not otherwise substantively amend a review panel report. The content, substance, and recommendations of a review panel report are those of the review panel, not the Delta Science Program or Delta Stewardship Council. The Delta Science Program will post the report after approval of the panel. The Delta Science Program may provide a courtesy copy of the report to the agency that produced the materials subject to review in advance of posting the

report. If the agency that produced the materials subject to review chooses to develop a written response, the response will be posted along with the review at the time it becomes available.

APPENDIX G. POLICY AND PROCEDURES FOR INDEPENDENT SCIENCE ADVISORS

Background

As part of its mission to provide the best available scientific information to guide management and inform policy in the Bay-Delta system, the Delta Science Program promotes and provides independent scientific advisors. Advisors are typically requested to give input on the development of processes, programs, plans or products; whereas review panels are used to evaluate completed processes, programs, plans, and products. The policies and procedures below describe how independent scientific advisory services provided by the Delta Science Program will be conducted.

Decision to provide advisors

Independent science advisors may be requested by any agency or other interested party. The Delta Science Program's decision to provide advisors will depend on other, sometimes competing, commitments of the Delta Science Program and the relevance of the advisors with respect to the goals and objectives of it and the Delta Stewardship Council. Moreover, the Delta Science Program will only agree to provide a science advisors if there is sufficient funding available for the advisory services, if there is sufficient time available to complete the advisory work and deliver one or more written products. The ultimate decision to provide science advisors rests with the Delta Science Program's Lead Scientist.

Planning meetings

Planning meetings for science advisors typically occur several times prior to and throughout the science advisors effort. The Delta Science Program will work directly with members of the requesting party and the authors of the document(s) being prepared with advisory input (if different from the requesting party). The requesting party and/or authors of the document(s) to be prepared with advisor input may:

- Communicate their expectations for the pending scientific advice
- Provide input on the Charge to the Science Advisors
- Inform the advisor schedule
- Identify desired expertise and make recommendations for selecting individual and/or a panel of advisors, inform the composition of advisors, and
- Provide pertinent background documents or other instructional materials to review through the Delta Science Program

Charge to the advisors

Charge questions are developed with input from the requesting party. The Lead Scientist has the final authority for the charge to the science advisors. Charge questions will be technical (or analytical) in nature, and will not include policy prescriptions (however, it is recognized that responses and other information in a review report may be used in future decision-making by resource managers and policymakers). Accordingly, charge questions and tasks will be crafted to best draw applicable guidance but not to solicit explicit policy recommendations or prescriptions.

The scope of the Charge to the Advisors will include background information (including the legal, regulatory, and management background necessary to set the full policy context for the Charge to the Advisors), questions and tasks for the advisors, a description of the role of the advisors and rules for their deliberations (if the science advisors are working as a panel), any required or relevant reading materials, and a schedule of deliverables.

Advisors

Independent science advisors may work independently or collectively as a panel to provide scientific advice. One or more science advisor(s) may be selected depending on the scope and scale of the services requested. If a panel of independent science advisors is requested and deemed appropriate by the Lead Scientist, between three and seven panel members will be selected by the Lead Scientist in consultation with the requesting party. Potential science advisors for individual or panel advisory services may be identified through Delta Science Program staff input, the Delta Science Program's science expert database, publication records on relevant topics, Lead Scientist, and other professional recommendations (i.e., from other leading scientists and the advisor requesting party). The Lead Scientist has the final authority for the selection of independent science advisors and will consider input from the advisor requesting party. The selection of panelists will consider an individual's standing in the scientific community, expertise in disciplinary areas and with technical skills relevant to the documents and technical issues subject to advice, and absence of a demonstrated conflict of interest. Advisors are expected to have a broad range of expertise including some familiarity with the geographic region, physical processes, policy issues, ecosystems, and species-specific aspects for which scientific advice is sought. Advisors provide written responses to advisory questions specified in their charge. Comments and advice are often provided over more than one exchange with the requesting party and/or author(s) of the product for which advice is sought.

Materials for comment

Materials under advice and subject to comment by independent science advisors include draft documents and pertinent background materials. Background materials will not be limited to the (specific) technical questions and issues in the charge to the advisors, but can include documents describing the legal and regulatory context of the advisory questions and tasks, and consider the management implications of materials provided to the advisors relevant to the objectives of the charge questions. Other study materials, or information identified as pertinent to the advisory effort introduced by advisors during their advisory work, can be used at the discretion of the advisors. Advisors are encouraged to request any additional information or other materials that might facilitate their deliberations and written comments. Stakeholders and other interested parties may submit materials to be considered by the advisory panel; however, final decisions relating to any materials to be provided to the advisory panel rest with the Lead Scientist.

Communication with advisors

No direct communications by interested parties, including document authors or the advisor requesting party, should be made with advisors on issues pertinent to the advisory effort during the time of advisor services without the knowledge and consent of the Delta Science Program. The advisors may be asked to disregard any communication received without the knowledge and consent of the Delta Science Program.

Public meetings

Independent science advisors efforts may or may not involve public meetings. Decision to include a public meeting as part of the science advisor effort will depend on the scope, scale, and stage of the effort under comment. The decision to include a public meeting will be up to the Lead Scientist in consultation with the requesting party. If the Lead Scientist determines there is a compelling reason to have a public meeting, advisors will communicate their comments and an opportunity for public comment will be provided as a part of any open (public) sessions of each meeting.

Public communications

A webpage accessible through the Delta Stewardship Council and Delta Science Program website will present background information on independent science advisor efforts undertaken, meeting agendas (if applicable), and identification of advisors convened, relevant materials, and advisory comments. If a public meeting is to be held, relevant materials and the agenda will be posted on the website at a minimum of 10 days in advance of the

advisory meeting. Scheduling and other information about that meeting and the availability of relevant advisory materials will be sent to the Delta Stewardship Council's listserv.

The Delta Science Program will compile and retain a record of the advisory effort, including the materials described above as well as any additional materials provided to the advisors including presentations from the public sessions of meetings.

Advisor comments, memos, and/or reports

The Delta Science Program may suggest grammatical or formatting edits of independent science advisor draft comments, memos, and/or reports to improve it, but will not otherwise substantively amend input from advisors. The content, substance, advice, and recommendations of a science advisory product are those of the advisor(s), not the Delta Science Program or Delta Stewardship Council. The Delta Science Program will post the final comments, memos, and/or reports after approval of the advisor(s). The Delta Science Program may communicate initial comments, memos, and/or reports to the advisor requesting party and/or document author(s) at any time during the advisory service. A copy of any final products by the advisor(s) and the exchange between advisors and the advisor-requesting party may be provided as a courtesy to the advisor-requesting party in advance of public posting.

APPENDIX H. SCIENCE COMMUNICATION

1. This is an outline of existing and potential science communication tools being used by the Delta Science Program that could be included in science communication strategies.
    a. Activities using existing communication tools
    b. Continue support for the open access journal, San Francisco Estuary and Watershed Science, and expand its visibility and effectiveness as a communication tool within the community and beyond
    c. Continue support for the San Francisco Estuary Partnership's Estuary News publication;
    d. Facilitate the transfer of information (research and monitoring designs and results, data, review papers, etc.) among scientists working in the Delta on a real-time basis using existing, expanded, and/or future web portals
    e. Continue support for existing scientific conferences including the biennial Bay-Delta Science Conference and the State of the Estuary Conference. These venues are opportunities to discuss new research findings, explore new initiatives, create new collaborations, promote interactions among scientists, managers, policy makers, educators, media personnel, and unite as a community
    f. Expand the number of workshops, seminars, and symposia currently being conducted—including brown bag luncheon seminars and symposia hosted jointly with the University of California, Davis, which are open to the public and free of charge
    g. Improve the existing Delta Science Program website to make it a more effective science communication tool
    h. Develop outreach materials summarizing recent scientific research results and findings specifically directed to policy and decision-makers
    i. Continue regular summaries of science events and recent research results communicated at non-expert levels during public meetings (such as the Delta Stewardship Council Meetings and the Delta Independent Science Board meetings)
    j. Expand science communication efforts on Social Media outlets
    k. Participate in educational opportunities

2. Develop new communication tools
    a. Establish shared guidelines for policy-science forums (Chapter 2, section 2.1)
    b. Develop information sharing with other large water and ecosystem management programs in the U.S. and internationally
    c. Identify mechanisms that allow agency scientists to access peer reviewed scientific literature that is not available through online open access journals.
    d. Develop an online repository for all Delta science on the internet—the repository would aggregate and organize the best scientific and educational information, making it available to scientists, policy makers, resource managers, the general public, educators, and students

APPENDIX I: DELTA SCIENCE PROGRAM ADAPTIVE MANAGEMENT LIAISONS

The Delta Reform Act and Delta Plan require the use of an adaptive management framework to improve the planning, implementation, and evaluation of restoration projects and water management actions. The Delta Science Program provides adaptive management liaisons for early consultation on adaptive management and best available science for Delta Plan proposed covered actions. Early consultation for covered actions help project proponents prepare consistency determinations and increases the likelihood that the best alternatives are chosen to advance program, plan, and system-wide goals and objectives.

Advice of Delta Science Program adaptive management liaisons may be useful to project proponents even if their projects are not covered actions subject to Delta Plan regulations. This advice may be especially useful to those projects and plans that have the potential to: (1) substantially advance the coequal goals; (2) add to the knowledge base and reduce uncertainties related to achieving performance measures in the Delta Plan; or (3) reduce other significant barriers to large-scale restoration or water management improvements, such as regulatory constraints. There are several advantages of early involvement by Delta Science Program staff in actions that have significant direct or indirect benefits to Delta ecosystem functions or water supply reliability for regions that use water from the Delta watershed. These may include:

- Savings in staff time for project proponents resulting from information on regional monitoring and other activities, advice on conceptual models, and assistance in networking with other programs
- A greater degree of accountability and transparency via broadly applicable performance measures through standardized approach to the use of science across agencies and programs
- Increased competitiveness in future grant applications for Water Bond funds, Integrated Regional Water Management projects, the Carbon Cap-and-Trade Auction Investment fund, and other sources

APPENDIX J. POTENTIAL SHARED MECHANISMS AND PROCESSES FOR EFFICIENT FUNDING TO SUPPORT DELTA SCIENCE PLAN IMPLEMENTATION

Below are strategies inspired by the Delta Science Plan and external science programs in marshaling resources to support science activities and infrastructure. A critical component of garnering support for science is effective communication of the benefits of advancing scientific knowledge for decision-making in the Delta.

Leveraging existing resources

- Use the Science Action Agenda and the efforts of the action 5.1 workgroup to identify priority science needs and where to focus funding efforts
- Utilize a web-based science investment tracking system (action 5.3) to identify what current expenses are, where inefficiencies exist and where additional coordination can occur to address common goals. *Examples include: re-aligning disparate research and monitoring efforts so locations and resources such as staff and tools can be better coordinated (Medellín-Azuara et al. 2017; Hanak et al. 2012)*
- Identify programs with overlapping or complementary responsibilities and work together to identify how to coordinate to reach common goals (Kark et al. 2016; Sutherland et al. 2016)
- Improve coordination of existing programs and organizations rather than creating new ones
- Implement more effective cost-sharing mechanisms and build on collaborative funding models
- Seek opportunities to leverage resources with other federal, state, and local agencies as well as industry, foundations, public benefit corporations, and stakeholders to enhance research and monitoring efforts (Liew 2007)
- Reduce overhead and transaction costs by using a shared set of funding mechanisms for different types of funding. *Examples of the funding mechanisms used by the Delta Science Program can be found in Appendix K*

Identify additional sources of funding

- Identify and engage political and public champions for science and utilize the science implementation plans (action 5.1) to develop the case for dedicated funding (state bonds and appropriations) and to expand existing federal funding
- Expand and strengthen partnerships with stakeholders, businesses, and similar programs—such as the SF Estuary Partnership, Integrated Regional Water Management Programs, and California Water Plan efforts.
- Investigate opportunities for unique partnerships, similar to what National Estuary Programs have done (e.g. The Department of Transportation, Resource Conservation Districts, Business transportation and housing agencies)
- Establish external financing through stakeholder, private investment, and foundation contributions
- Identify beneficiaries of the program or project associated with avoiding, reducing, and mitigating the impacts of the variety of human induced stressors identified in the Delta and explore mechanisms to identify cost sharing opportunities and increased resources through external investors[68]

[68] A potential model can be based on that used by the Blue Forest Conservation: http://www.blueforestconservation.com/

APPENDIX K: POLICY AND PROCEDURES FOR RESEARCH FUNDING

Funding scientific research is a key means for the Delta Science Program to achieve its mission to "provide the best possible scientific information to inform water and environmental decision making in the Delta." There are three basic processes that the Delta Science Program uses to select research projects for funding: Proposal Solicitations, Requests for Proposals, and Directed Actions. The choice of which of these processes to use for research needs depends on the source of funding, the time frame for the scientific information needed, and the specificity of the information needed. Each of these three methods for funding research is described here. The decision about which funding process to use ultimately rests with the independent Delta Science Program's Lead Scientist in consultation with the Delta Stewardship Council's Executive Officer. All proposals will be subjected to administrative and scientific peer review as described below, under the direction of the Lead Scientist. All reviewers will be screened for potential conflicts of interest as described in Appendix L.

Proposal Solicitations

This funding method is implemented through the development of a Proposal Solicitation Package and is a competitive process for distributing available research funding. Proposal solicitations are used when the research needs (topics) are relatively broad and the funding is available to a broad range of potential recipients. Funding may come from several sources with differing constraints and priorities – for those funded fully or in part by the Delta Science Program, the competitive solicitation must be based on the guidance provided in the Science Action Agenda. Proposals submitted by the due date and in accordance with the proposal solicitation package instructions receive independent external scientific review with final recommendations for funding made by the Lead Scientist. Proposal solicitations will be conducted as based on the following criteria.

Planning

While topics for a proposal solicitation may come from existing planning efforts, it is important to have up-to-date input from the agencies and institutions participating in the solicitation. A proposal solicitation planning group, organized by the Delta Science Program, will help to develop the solicitation topics and will make recommendations on other elements of the proposal solicitation package. Final approval of the proposal solicitation package rests with the Lead Scientist.

The proposal solicitation package

The proposal solicitation package is a comprehensive package of information for applicants wishing to submit a proposal for research funding. The proposal solicitation package covers the priority research topics, eligible applicants, approximate amount of funding available, constraints on the available funding, instructions for proposal submission, due date, the review process, criteria for review, how proposals are recommended for funding, and how final funding decisions will be made. The proposal solicitation package may be supplemented with guidelines required by the funding legislation.

Review of proposals

Proposals first undergo administrative review to determine if they are responsive to the proposal solicitation package, are complete, were submitted on time, and the applicant is eligible. Administrative review may also include an assessment of past performance by the applicants on previously-funded research grants, if applicable. Applications that pass administrative review are distributed to subject matter experts for scientific review. All reviewers are given the same set of instructions and criteria for rating the proposals. Each proposal is reviewed by no less than two, and preferably three or more, individual reviewers. The Lead Scientist organizes a review panel

meeting that consists of technical experts in fields relevant to the topics and proposals. The purpose of the review panel is to make funding recommendations to the Lead Scientist.

Recommendations for Funding

Based on the recommendations of the review panel, the Lead Scientist will make draft funding recommendations that will be noticed for public comment. The Lead Scientist may recommend partial or reduced funding for specific proposals. After reviewing the scientific reviews and public comments, the Lead Scientist will make funding decisions and will consult with the Executive Officer of the Delta Stewardship Council on those decisions.

Requests for Proposals

Requests for proposals are used when the project scope is well developed but many individuals or entities may be qualified to do the work. That is, the "what" is known but not the "who." These situations arise when scientific research or planning activities are needed to support an important management decision, or to generate information essential to create the foundation for a proof-of-concept for larger projects. Many of these opportunities tend to occur outside the normal proposal solicitation package window. Requests for scientific research or planning needs to be consistent with the Science Action Agenda and/or be identified and documented as a key uncertainty by one or more collaborative science venues (e.g. Collaborative Adaptive Management Team, Bay or Delta Regional Monitoring Program) and/or create synergies with projects already underway or with a committed funding source in place. Requests for proposals follow well established State policies and guidelines and follow a formal competitive bidding process open to any eligible and qualified individual or team. For the Delta Science Program, the preferred process is as follows:

- The request for proposal is posted online (qualified individuals or teams may be notified of the request for proposal posting directly)
- Proposals including cost proposals are submitted
- Responsive proposals are reviewed and scored by an evaluation committee that will include appropriate discipline-relevant scientists determined by the Lead Scientist
- The contract is awarded to the highest scoring proposal.

Directed Actions

Similar to the "Rapid Response Grants" process of the National Science Foundation, Directed Actions are appropriate when the scientific research or advice is needed quickly, and/or an important opportunity would be lost if the proposal waited for the standard competitive proposal solicitation package or request for proposal process. Typically, there is only one entity (individual or team) that is qualified and available to do the work within the desired timeframe. Examples might include scientific research in response to a natural event such as a flood or drought, detection and description of a new invasive species, or proposals addressing high priority management issues developed through a collaborative process. The Directed Action funding process is non-competitive but must comply with Delta Stewardship Council rules. As with science request for proposal, requests for Directed Actions must be consistent with the Science Action Agenda and clearly be identified and documented as a key uncertainty by one or more collaborative science venues (e.g. Collaborative Adaptive Management Team, Bay or Delta Regional Monitoring Program) and create synergies with projects already underway or with a committed funding source in place. Rapid response may be necessary or justified when an unusual event occurs that provides an opportunity for learning and advancing the state of knowledge, such as an extreme natural event, human-caused disaster, or an adaptive management action that may serve as a controlled large-scale experiment with high probability of generating one or multiple measurable signals to test key hypotheses.

Funding decisions will be based on:

- Availability of funds
- Benefits that the grant would accrue to our understanding of the Bay-Delta system
- Urgency and unique nature of the problem to be addressed
- Expected contribution to supporting management actions or policy decisions
- Scientific and technical merit
- How the proposal was developed (Was it developed through an open transparent collaborative process that included stakeholder participation?)

THE REVIEW PROCESS AND DECISION

Timing will be critical for directed actions. The proposal should be submitted to the Delta Science Program. The Lead Scientist will decide whether the urgency and topic merits further consideration. If not, the proposal will be returned to the proposers with confidentiality of the proposal maintained and an explanation of why the proposal is not being considered further. Applicants are strongly encouraged to talk to Delta Science Program staff before submitting a proposal. The Lead Scientist will determine the specific set of proposal reviewers depending on the scope of the proposal and the magnitude of the problem. Unless the proposal has already been independently reviewed, the proposal will be reviewed by at least:

- The Delta Science Program scientist
- One discipline-relevant scientist from within the Bay-Delta community of scientists
- A State or local agency manager with direct knowledge of the relevance of the activity

The Lead Scientist may request additional reviews by external discipline-relevant scientists from outside the Bay-Delta science community. The Lead Scientist will make the final decision and may approve, approve with specific conditions, or reject the proposal. Because approved Directed Action proposals meet an urgent need, funding of approved proposals will be pursued as quickly as feasible and should be of limited duration, normally less than two years.

APPENDIX L: CONFLICT OF INTEREST POLICY FOR EXTERNAL RESEARCH PROPOSAL AND FELLOWSHIP APPLICATION REVIEWERS, ADVISORS, AND APPLICANTS

To achieve its mission to "provide the best possible scientific information to inform water and environmental decision making in the Delta", the Delta Science Program must take steps to ensure the integrity of its work products and processes. To do so, it must take reasonable steps to guard against even the perception of conflict-of-interest. Of course, acts that are banned by State conflict of interest laws, regulations, and Delta Stewardship Council policies are prohibited. Actions or activities that could create the perception of bias, favoritism, or unfair funding decisions are the subject of this policy.

Situations that may have conflict-of-interest implications include:

- Reviewing proposals or applications
- Advising the Delta Science Program on Proposal Solicitations or Science Fellows Applications
- Submitting a bid, proposal or application

Proposal or application reviews

The Delta Science Program avoids financial, professional or personal conflicts-of-interest by selecting reviewers who have no financial, professional or personal connection to the proposals that they review. In addition, the Program seeks to avoid selecting reviewers for whom there may be a perception of bias. Proposal reviewers are selected based on their scientific and technical expertise, not based on their affiliation with an agency or organization. Because potential conflicts-of-interest are not always apparent, the Delta Science Program expects potential reviewers to promptly disclose any direct or indirect financial, professional, personal or other connection to a proposal, so that the Program can make a determination about the suitability of that reviewer for the specific proposals at issue.

A reviewer has a disqualifying conflict-of-interest if the reviewer:

- Has assisted in the development of the proposal to be reviewed in any way
- Will receive a direct or indirect financial benefit from the funded project
- Has a conflict of interest under California law

A reviewer has an institutional, personal, or professional connection to a proposal applicant that may disqualify them if any of the following relationships were applicable during the past four (4) years:

- Collaboration on research
- Co-authorship of publication(s)
- Thesis or post-doctoral advisor/advisee relationship
- Supervisor/employee or independent contractor relationship
- Reviewer and an applicant are employees of the same local, State or Federal agency; university; or private firm—even if they are in different divisions
- Reviewer and applicant have a close personal relationship

Institutional, personal, or professional connections will not necessarily disqualify the reviewer. The Delta Science Program Lead Scientist will review the information submitted regarding such connections to the proposal to

determine if the disclosed connections are sufficient to compromise the objectivity of the reviewer. If the Lead Scientist determines that any disclosed connection may result in bias, favoritism, or an unfair funding decision, the Delta Science Program will reassign the proposal.

Independent science reviewer

An independent science review panel member is contracted for their expertise relevant to the material to be reviewed. The consideration of an independent science expert for their role as a reviewer has a disqualifying conflict-of-interest if the expert:

- Has assisted in the development of the material to be reviewed
- Will receive a direct or indirect financial benefit from the funded project
- Has a conflict of interest under California law

Providing advice to the Delta Science Program

Public Contract Code section 10365.5 provides in part as follows:

"(a) No person, firm, or subsidiary thereof who has been awarded a consulting services contract may submit a bid for, nor be awarded a contract for, the provision of services, procurement of goods or supplies, or any other related action which is required, suggested, or otherwise deemed appropriate in the end product of the consulting services contract."

Because of this prohibition, any person, firm or subsidiary thereof who may be acting as an advisor to the Delta Science Program should consider whether such advising role would preclude them from subsequently submitting a bid or being awarded a contract. When commenting on topics or priorities for funding programs, Delta Science Program contractors or participants in Delta Science Program committees or work groups may be acting as advisors and should consider how their participation might affect future funding opportunities.

Submitting a bid, proposal, or Application for Fellowship

Any person, agency, or institution that is considering submitting a bid, proposal, or application for funding or fellowship opportunity should disclose their personal, agency, or institution's participation in any Delta Science Program committee or workgroup that has provided advice on topics or priorities for funding. To avoid the perception of bias, favoritism, or unfair funding decisions, the Delta Science Program may recommend against submittal of the bid, proposal, or application in question.